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Electric Furnace Operating Data

Present and Future Prospects of Electric Furnaces—Figures Showing Various Items of Expense Involved in Melting of Steel — Unit Costs — Raw Materials and Finished Product

By C. H. REEDER

A growing demand for iron and steel products of a high standard and of an unvarying quality has centered the attention of the producers of such materials on the electric melting furnace. Many manufacturers of high-grade iron and steel products have hesitated to depart from their older and tried methods of production for various reasons, best known to themselves, but the insistent demand for an unvarying quality of product has influenced many of the progressive manufacturers to adopt and make use of the electric furnace.

Electric furnace equipment is by no means new or untried, having been experimented with and used almost since the beginning of experimentation with electricity itself, but the developments within the past 10 or 15 years, together with the development of a demand for quality products, have been required to place the melting furnace on a high plane in actual commercial service. Normal growth of the electrical industry, making available sources of power of a capacity and reliability suitable to furnace operation, has been no small feature in the de-

Fig. 1.—3.5-Ton Electric Furnace in Plant of Racine Steel Castings Co., Racine, Wis.

velopment of the furnace to its present position in the iron industry. Now, in turn, the furnace bids fair to be a factor in the further development of the electrical industry by providing it

Fig. 2.—Electric Furnace, Showing Charging and Discharging Doors.

with new purchasers of both power and equipment on a large scale.

Data presented in this article were secured in the plant and from the records of the Racine Steel Castings Co., owned and operated by the Bell City Malleable Iron Co., Racine, Wis., and represents the normal operating performance of the 3.5-ton furnace installed in 1916 and operated since that time. The illustration shown in Fig. 1 gives an idea of the size of the installation in connection with this furnace. The third electrode, this being a three-phase furnace, is concealed behind the electrode in the foreground, but the three supply cables and electrode supports are plainly visible. Regulating equipment is inclosed by the screened partitions, and the three motors for raising and lowering the carbons are mounted at the back of the furnace near the floor. Transformers for converting the incoming service voltage from 13,000 volts to furnace voltage are completely inclosed and protected from heat and accident by the brick vault just beyond the regulating equipment. A switch for opening the main supply lines is shown at the extreme right of Fig. 2, which gives another view of the furnace and shows the third electrode. Fig. 3 gives a view of the general foundry layout and shows the furnace in its relation to the casting floor, which is to the right in the illustration and about half beyond and half forward from the furnace. Two cranes, one of 5-ton and one of 7.5-ton capacity, run the entire length of the building and serve to handle flasks, molds, castings, etc., and to facilitate any heavy work required about the furnace itself or on other equipment or materials.

Nature of Furnace Power Demand and Load.

Power for the operation of this installation is taken at high voltage from the lines of the Wisconsin Gas & Electric Co. and is reduced to a potential of 112 volts through suitable transformers installed just back of the furnace, as already described. Observation of the meters indicating the input during the melting period shows a fairly steady input of approximately 200 kw. per phase, with variations sometimes as high as 400 kw. during periods of electrode adjustment. The power-factor indicator shows a slightly varying indication not far from unity.

Records compiled for the past three months show a total power charge against the furnace amounting to 159,600, 145,600 and 180,600 kw-hrs. This amounts to an average daily consumption of 5281 kw-hrs., including every day in the month, or to 6149 kw-hrs. for every week day during the entire period. The average day from the time current is turned on until the last heat is poured into the ladle is 12 hrs., thus indicating an average load of 512 kw. during the working day, which checks quite closely with the readings of the indicating meters when due allowance is made for the off time during the charging periods. Such a record speaks well for the central-station service as a source of reliable power supply, and also speaks well for the furnace business as a source of steady and continuous load to the central station. Further and more detailed examinations of the records simply bear out the conclusions already drawn that the electric furnace is steady in its performance and that it can depend on reliable central-station service.

Uniformity of input or power demand depends, of course, upon the nature and effectiveness of the electrode regulation equipment provided. Defective equipment or careless operation may result in a widely varying load, producing high power costs, poor product and excessive maintenance charges. Regulation of electrodes in this installation is either automatic or manual as desired. Automatic regulators control the operation of the regulating motors, raising or lowering each electrode to maintain the power input per phase at a fixed value. Three indi-

Fig. 3.—General View of Foundry, Showing Furnace in Distance.

cating wattmeters show at all times the input per phase, and three hand-operated rheostats provide for the setting of this fixed input at any desired value. Three motor controllers are provided for the direct hand regulation of the electrode motors, and by the manipulation of these controllers the operator may take full charge of the

Fig. 4.—View of Finishing Floor, Showing Typical Product of Electric Furnace.

power input on any or all phases at any time that such a procedure is warranted.

Raw Materials Used.

Piles of material, shown near the furnace in Fig. 1, are composed of foundry scrap and punchings and cuttings from automobile and boiler factories and similar sources. The foundry scrap consists of sprues, risers and other similar material, and, of course, is of the same quality as the average finished product. Other scrap used is composed of small pieces sheared or punched from a good grade of material, but of such size as to be of but small value in any furnaces other than those of the electric type. Slags and fluxes used depend upon the raw materials used and the product made, and are too well known to merit special comment and need no further discussion than the cost data presented later.

Quality and Character of Product.

Truck and tractor parts and similar materials comprise the greater part of the entire output of this furnace. Many other parts are made, including pulleys, flanges, gears, etc., a typical run of product being shown in Fig. 4. Pieces as small as 0.25 lb. each and as large as 5000 lbs. are made with this furnace, the general average weight per casting being about 20 lbs. Approximately 65% of the material melted finally comes to the shipping floor to be sent out as good castings; about half of the remainder comprises sprues, gates, over-iron, etc., and is returned to the furnace for remelting. Tests made on standard test pieces developed an ultimate tensile strength of as high as 75,000 lbs. per sq. in. and elastic limit of 46,000 lbs. per sq. in. Bending tests and fractures almost invariably indicate a good grade of material, and chemical analysis shows a uniformity of composition suitable to the character of the work being produced. The regulation of the chemical composition of iron or steel melted in the electric furnace depends almost entirely upon the desires of the operator to work within fixed limits.

Various Elements of Cost.

Raw material costs will depend to a great extent upon the availability of a supply of scrap materials for melting. The costs of the melting material and power will vary with different localities, and will depend somewhat on the nature of the product to be made and on the method of handling the furnace. However, the figures given in the accompanying tables, and showing various elements of cost for three consecutive months of this year, give a fair basis for the determination of what the costs are under a specific set of conditions. These figures are based on the tons of finished product, which amounts, as stated before, to approximately 65% of the materials melted. About half of the remaining 35% is returned for remelting, so that altogether

POWER CONSUMPTION FOR AN ELECTRIC FURNACE.

Month.	Total Tons Finished Castings.	Total Power Input in Kw-Hrs.	Kw-Hr. per Ton Finished Castings.
March	178.02	159,600	896
April	148.09	145,600	984
May	194.72	180,600	928

MISCELLANEOUS COSTS PER TON OF FINISHED CASTINGS.

Month.	Operating Labor.	Repair Labor.	Electrodes.	Flux.	Refractories.
March	$4.16	$0.62	$3.81	$1.75	$0.97
April	4.48	0.51	3.65	1.89	0.61
May	4.16	0.63	4.07	2.26	0.73

about 121% of the finished product must be provided in new material for melting.

Insofar as labor charges and investment charges per unit of output are concerned, the rate of operation is a vital factor in the ultimate cost. Rapid handling greatly reduces the furnace radiation and cooling losses, and at the same time increases the total tonnage output. The periods of no-power consumption are also reduced by rapid handling of the melted and new charge, with a corresponding increase in the load-factor. The working day in this foundry begins at 4:30, when the current is turned on, and continues for sufficient time to run either four or five heats. Various time elements of the day are as follows: At 4:30 a.m. current is turned on; the electrodes are melted through to the bottom of the charge by 5:30 a.m.; at 6:00 a.m. the furnace is skimmed and at 6:45 the furnace is ready to pour, the charge having been tested, reslagged and treated with the required fluxes. By 7:05 a.m. the pouring is finished and a new charge is put into the furnace. Succeeding charges require from 2 to 2.25 hrs. each, the time being shorter than for the first charge because of the fact that the furnace remains hot during the pouring and recharging period.

Floor space for molding, of course, will not vary greatly from that required with other equipments, the nature of the product to be made determining to a great extent the amount and character of floor space needed. In this particular case the entire building housing furnace, transformers, materials and miscellaneous equipment is 320 ft. long by 80 ft. wide, the molding space required for one average heat being approximately 5000 sq. ft., and the total molding floor provided being 50 ft. wide by 220 ft. long.

The character of the electric-furnace product, together with the resultant demand for an increasing output, indicates that this industry has a period of rapid and healthy growth ahead of it; chief among the limiting factors in this development are the capacity of furnace makers to supply equipment, and the available sources of power in the required quantities and the supply of trained operators. This last feature is probably the most important item and will in the end determine more than any other single factor the growth of the industry.

AIR SCREENS FOR PROTECTING FURNACE WORKERS.

Workers tending furnaces who are required to examine the glowing materials at frequent intervals suffer considerably from the enormous amount of heat radiated. The heat rays are also very injurious.

Various devices have been employed to minimize the ill-effects of these radiations. For example, water-cooled furnace doors have been tried, but they furnish protection only so long as the doors are closed. Devices for drawing off the hot air in front of the furnace, such as centrifugal exhausters, have been tried out, but these possess the objection that the workers are subjected to great temperature variations, which affect their efficiency and tend to injure their health.

It has been claimed quite recently that the most effective device is one that may be fixed immediately behind the furnace door. This is a narrow oblong nozzle through which cold air is blown upward, thus imposing a screen of relatively cold air between door and furnace. This arrangement is claimed to give adequate protection to the workers.

CONDUCTIVITY OF ALLOY INDICATES ITS CONSTITUTION.

In a paper on the "Measurement of Electrical Conductivity in Metals and Alloys," read before the Faraday Society, London, J. L. Haughton stated that the study of the electrical conductivity of alloys throws a considerable amount of light on their constitution. This study has generally been carried out by measuring the conductivity of the alloys at room temperature and plotting a curve connecting conductivity with composition. A better method is to plot the temperature coefficient of resistance against composition. These methods, however, are limited to the study of the constitution of the alloys at comparatively low temperatures, and much valuable information can be obtained by plotting the curve connecting the composition and temperature and using a series of such curves in the same way as the ordinary thermal curves. He described a method which can be employed for this, which consists of measuring the voltage drop along a definite length of a specimen through which a constant current is flowing. This voltage drop is compared with that given by the same current passing through a standard resistance. Due correction can be made for errors arising from e.m.fs. and other sources. The specimen itself is heated up in a furnace so constructed that the temperature along it is exceedingly uniform.

INTRODUCTION OF AIR INCREASES FURNACE EFFICIENCY.

A time saving of 25 to 50% in the production of electric steel has been accomplished by a recently developed method of blowing air into the solid charge of steel in the furnace.

After the furnace has been tapped and any necessary repairs made to bottom and banks, the furnace is charged with scrap. This immediately absorbs heat from the furnace lining and by the time the whole charge is in the furnace the lower part will be incandescent. The electrodes are then lowered and the circuit closed.

Air is then turned on the incandescent portion of the charge at any convenient pressure and by a 1-in. pipe. The carbon monoxide formed when the air strikes the metal is immediately converted into carbon dioxide, burning with a white flame which melts the metal quite rapidly. As the metal melts, the air nozzle is raised, playing on the solid mass of metal until all is molten.

Oxidization of the carbon, silicon and phosphorus causes such a great rise in temperature that the total melting time can be reduced between 25 to 50%, it is claimed. This corresponds to a reduction in energy consumption of between 150 and 250 kw-hrs.

Resistance and Reactance of Electric Furnace Leads

Importance of Minimizing Loss of Pressure in Secondary Connections Between Transformer and Furnace—Difficulties Encountered Due to Large Alternating Currents at Low Voltage

When alternating currents, measured in thousands of amperes at pressures rarely exceeding 100 volts, are carried by flexible conductors between the furnace and the secondary terminals on the transformers the percentage drop in pressure, even when the distance is made as small as possible, may be considerable. This loss of pressure is due not only to the resistance of the conductors but also to the fact that when the current is anything from 10,000 to 50,000 amperes, the reactive pressure drop, due to the magnetic field surrounding the conductors, may be considerable. This is one reason why merely increasing the cross-section of the conductors will not overcome the difficulty. Other reasons for avoiding conductors of very large cross-sectional area are the high cost, the need of flexibility (in order that the furnace may be tilted when pouring the metal), and what is known as "skin effect."

Brief Explanation of "Skin Effect" in Large Conductors.

A small percentage of the total magnetic flux of induction which always links with an electric current is actually in the material of the conductor itself. This does not cause any uneven distribution of current density when the conductor is carrying continuous currents; but, with alternating currents, the flux will alternate likewise and generate counter e.m.f.s which are somewhat greater near the center of the conductor than at the circumference. This results in the current density being no longer uniform over the entire cross-sectional area of the conductor but somewhat greater near the surface than at the center.

Imagine a straight length of cable of fairly large cross-section, through which a steady continuous current is flowing, the return circuit being a considerable distance away. The magnetic induction due to this current will not be only in the non-conducting medium surrounding the wire but a certain amount, due to the current in the central portions of the cable, will be in the substance of the conductor itself. In other words, the magnetic flux surrounding one of the central strands of the cable will be greater than that which surrounds a strand of equal length situated near the surface. It follows that, if the circuit be now broken, the current will die away more quickly near the surface of the conductor than at the center, and, for the same reason, on again closing the circuit the current will spread from the surface inward.

If, now, the conductor be supposed to convey an alternating current, it is evident that, with a sufficiently high frequency (or even with a low frequency if the conductor be of large cross-sectional area), the current will not have time to penetrate to the interior, but will reside chiefly near the surface. This crowding of the current toward the outside portions of the conductor has the effect of apparently increasing the resistance, and it follows that if I is the total current in a cable of ohmic resistance R, the power lost in watts would no longer be I^2R, as in the case of a continuous current, but I^2R', where R', which stands for the apparent resistance of the conductor, is k times greater than R, its true resistance. The multiplier k may be calculated by means of the formula:

$$k = \frac{1 + \sqrt{1 + F^2}}{2}$$

where F is a factor proportional to the quantity area of cross-section multiplied by frequency. The value of F for copper is,

$$F = 0.0105 d^2 f$$

and for aluminum,

$$F = 0.0063 d^2 f$$

where d is the diameter of the conductor in inches and f is the frequency in periods per second. This formula is based on the assumption that the return current is at an infinite distance; but this assumption introduces no appreciable error when calculating skin-effect factors.

It will be observed that so long as the product d^2f remains unaltered the multiplier k is constant, provided the material remains the same. Thus if, when doubling the frequency, the cross-sectional area of the (circular) conductor is halved, the ratio:

$$\frac{\text{resistance to alternating currents}}{\text{resistance to continuous currents}}$$

remains unaltered.

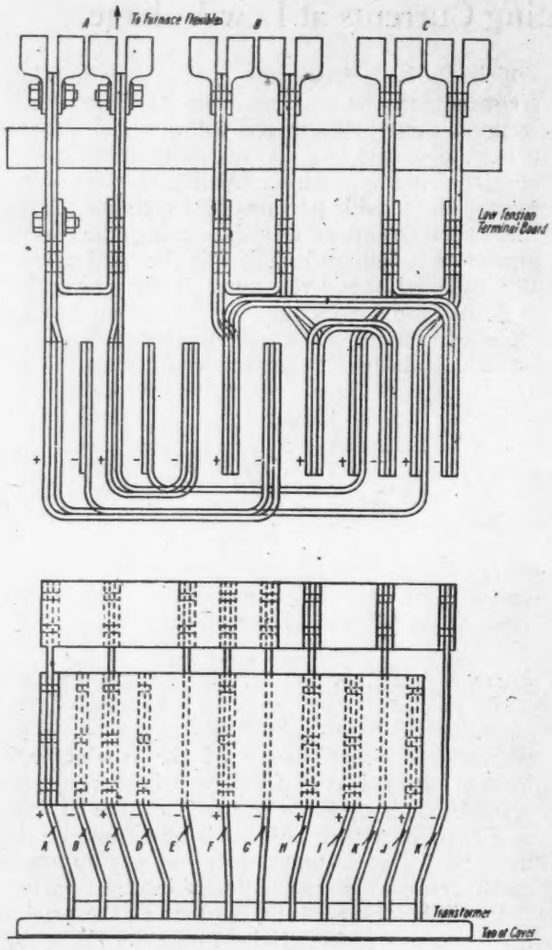
In regard to the material of the conductor, the value of F in the formula is directly proportional to the specific conductivity of the metal, so long as the frequency remains constant. Thus if F is known for a conductor of given diameter, made of copper, its value for any other "non-magnetic" material is given by the ratio:

$$\frac{\text{conductivity of metal of conductor}}{\text{conductivity of copper}}$$

If the conductor is of iron (or other "magnetic" material) the value of k may be much greater than this ratio would indicate.

It is a not uncommon belief that when aluminum conductors are used in place of copper the

larger diameter necessary to give the same conductivity will lead to a greater loss through "skin effect." But the above multiplying ratio makes it clear that the percentage increase of losses with alternating currents of the same frequency will be independent of the material of the conductor (iron excepted), because the greater cross-sectional area necessary to maintain the same ohmic resistance when a wire of lower conductivity is used is evidently exactly balanced by the higher specific resistance of the metal.



Method of Making Delta Connections at Terminal of Transformers for Electric Furnace Operation.

It will be found that the "skin effect" coefficient (k) by which the true resistance of a conductor must be multiplied in order to obtain its apparent resistance when carrying alternating currents is very small for frequencies of 25 and 60 cycles, provided the diameter of the conductor is not large.

On a 60-cycle circuit the conductor would have to be 1 in. in diameter to obtain a 10% increase in resistance. A diameter of 1.5 ins. would, however, increase this amount to about 40%, while, with a 2-in. conductor, the resistance to alternating currents—and therefore the I^2R losses—would be approximately 1.75 times as great as when the conductor is carrying continuous currents. On 25-cycle circuits the difference is smaller, as indicated by the formula.

By dividing a heavy conductor into several smaller conductors and connecting these in parallel, the skin-effect coefficient may be reduced, but the actual ohmic loss of pressure cannot be very easily calculated because the spacing and relative position of the parallel conductors have an important effect on the flux distribution both in and around the individual conductors, and therefore upon the distribution of the current density.

The skin effect is less marked in flat-strip conductors than in cylindrical wires or cables, but the coefficient (the multiplier k) is less easily calculated. If a cylindrical conductor of large cross-sectional area is replaced by a number of smaller conductors of the same total cross-sectional area placed side by side in the same plane, the result will be very similar to what would be obtained by rolling the original solid conductor into a strip of about the same thickness as the diameter of the smaller (parallel) conductors. By specially arranging the parallel conductors and interlacing them with those carrying the return currents, the skin effect may be still further reduced.

Reactive Voltage Drop in Conductors Carrying Large Alternating Currents.

The above considerations lead naturally to the question of reactive drop and the interlacing of conductors with a view to making this as small as possible. The flux due to and linking with the electric current has so far been considered only in its relation to the distribution of current over the cross-sectional area of the conductors, and it has been shown that, with large conductors carrying alternating currents, the resistance may be appreciably increased, with a corresponding increase of pressure drop and power loss.

The reactive pressure drop caused by the flux linkages does not represent energy loss, but it may very seriously reduce the power-factor of the furnace load, and even lower the voltage at the carbon electrodes to such an extent as to interfere with the proper operation of the furnace. Low power-factors are very objectionable from the central-station point of view and although a certain amount of reactance is necessary and even desirable in the circuits supplying current to electric furnaces, it is very rarely advisable to provide secondary leads with greater inductance than would be obtained with the shortest cables and best arrangement of interlaced conductors planned to keep this quantity as low as possible.

The magnetic flux surrounding a conductor carrying a large current may be considerable if the return conductor is at a great distance; i. e., if the loop formed by the outgoing and return conductors includes a large area; but when the outgoing and return conductors are brought close together this loop is reduced in size and the injurious flux of self-induction which links with the circuit is reduced, thus improving the power-factor of the system and preventing unnecessary reactive pressure drop.

In furnace work the pressures on the secondary side of the transformers are always low, and since no large spacing or high degree of insulation is necessary between conductors of opposite polarity these may be brought close together and

the reactive pressure drop in the leads is therefore to some extent under the control of the engineer who plans the arrangement of the secondary connections to the furnace terminals.

The arrangement of bus bars and connections between the transformer terminals and the stationary ends of the flexible leads is a matter which well repays careful study, not only with a view to saving copper, the cost of which is necessarily high, but also in order to avoid excessive inductance.

ARRANGEMENT OF CONNECTIONS BETWEEN SECONDARY TERMINALS.

The illustration shows a good arrangement of the heavy bus bars and connections between the secondary terminals on the top of a three-phase shell-type transformer and the terminals *A, B* and *C*, from which the flexibles are carried to the furnace electrodes, which will naturally be as close as possible to the transformer. By following the connections on the diagram it will be seen that the transformer windings are delta-connected.

If the distance between transformer and furnace is considerable, it is very important to interlace the conductors from the transformer terminals to the point where the delta connections are made. Thus, if the current from phase *A* of the secondary winding is carried by three outgoing conductors, 1, 2 and 3, and by three return conductors, 4,5 and 6, the proper arrangement of these connections when carried side by side on a straight run should be 1, 4, 2, 5, 3, 6, and not 1, 2, 3, 4, 5, 6. Phase *B* and phase *C* would be dealt with in the same manner. By this means the inductive voltage drop can generally be kept within reasonably small limits.

The inherent reactance of an electric arc furnace is about 30%, and if the external reactance of transformers and connections amounts to another 30%, making a total of 60%, the power-factor would be 0.8, which is not unusual. A power-factor appreciably lower than this would, however, be objectionable, especially from the standpoint of the central station.

TYPES OF MOTORS USED FOR FURNACE OPERATION.

D-C. Motors for Moving Electrodes Offer Advantages of Dynamic Braking—Standard Practice in Connection With Tilting Motors.

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Motors for moving the electrodes of electric steel furnaces are usually mounted on the furnace structure and tilt with the furnace, while motors move the electrodes of ferro-alloy furnaces through a cable and winch drive. Motors for electrode service are preferably of d-c. type, in order that the advantages of dynamic braking may be secured.

In ferro-alloy service or special cases where the service is not severe, a small d-c. motor (2 hp.) may be utilized or an a-c. motor equipped with a solenoid brake may prove adaptable. However, because of the advantage of dynamic braking, d-c. motors are used extensively.

In order to pour the furnace charge, steel furnaces are tilted by a motor acting through a geared and sometimes counter-weighed mechanism. While pouring, the furnace containing the charge of molten metal must be held stationary in any desired position, and hence a magnet-operated brake is always included with the tilting motor. The particular design of furnace-tilting mechanism, as well as the capacity of the furnace, will determine the size of the tilting motor required. In general, tilting motors range from 10 to 150 hp.

11-Hp. Motor for Tilting 2-Ton Electric Furnace in Plant of Driver Harris Co., Harrison, N. J.

Because the motor must accelerate under load,

Rear View of 2-Ton Heroult Furnace, Showing Method of Mounting Winch Motors and Arrangement of Leads from Transformer to Furnace.

a series motor with magnetic brake (if a d-c. supply is available), or a variable-speed, wound-rotor, induction motor with solenoid-operated brake (if an a-c. supply is available) is standard practice. The tilting motor is controlled through a suitable reversing controller.

Safeguarding Electric Furnace Operation

Means of Preventing Accidents in Foundries, With Special Reference to Safety Measures in Connection With Electric Furnaces, Substations, Transformers and Other Equipment

In discussing the precautionary measures that should be taken in the operation of electric furnaces whether for melting steel, brass or other alloys it is necessary to analyze the dangers against which precautions are to be taken. These may be divided into two classes. In the one class belong all those hazards of the foundry regardless of how the heat is produced. In the other are those dangers directly chargeable to electricity as the heating medium.

Accidents may occur to the furnace itself through failure of materials or misunderstandings among the operators. There is the danger of electric shock, caused directly or indirectly. There are the injuries that follow the radiations of infra-red and ultra-violet rays produced by heat and the electric arc, respectively, the one chargeable to the process of melting and the other to the melting medium.

The possible or latent dangers of the electric furnace are about the same as those of other types of furnaces. The working medium always constitutes a danger. If solid fuel is used, heat and poisonous gases are produced. If oil fuel is used there are the added dangers of fire explosion and asphyxiation (remote). With electricity there is the danger of shock and fire, but if the installation is properly made and properly maintained electricity appears to be the safest medium.

Mishaps in the foundry proper comprise such accidents as spilled metal due to upset crucibles, etc., contact of water or liquids with the furnace or molten metal, splashing during pouring, etc. These accidents happen, no matter what way the metal is melted.

Foundry Labor.

Foreign labor is used to an exceptionally large extent in the steel mills and foundries. Oftentimes different nationalities work together, each understanding only the very commonest words and directions. These men do as they are told without asking; they are not accustomed to think for themselves. This situation calls for every possible safeguard against ignorance and misunderstanding.

Warnings and instructions should be placed in conspicuous places and in as many languages as are required for the education and information of all. The need for making all equipment foolproof is obvious, because of the different mentalities and operations involved around the electric furnace, the rate at which things happen and the space involved.

Familiarity breeds contempt. What is wanted is not the fear that danger exists where there is ignorance, but the respect and caution that are born of understanding. These come about only by wise, continual education, safety meetings and foremen's talks with their men.

Electrical Precautions.

With the electric furnace, electricity is only a means to an end. The primary purpose is to produce steel or alloys, and the attention is devoted to this purpose. That the process is being done electrically is of secondary importance.

The result is that charging the furnace, melting the charge and disposing of it receive almost all the attention. Another reason for this is that the men doing the work are usually ignorant of things electrical. That there are so few accidents speaks well for the methods in use.

But the fact that there are live parts and that electricity is present calls for caution and precaution. Responsibility for the electrical apparatus should rest with electrical men. The handling of dead and live electrical equipment should rest upon as few persons as possible so that the likelihood of misunderstandings is minimized.

A danger sign should invariably be located beside electrical apparatus. The apparatus may not actually impose a danger, but the psychological effect of a danger sign encourages caution. The familiar sign of skull and cross-bones recommends itself for universal use. It is significant and impressive; it is of international understanding, and so is equally effective regardless of the nationality of the workers. In using this sign, the recommendations of the National Electric Light Association should be followed out namely, white skull and cross-bones upon a red background.

Electric Shock.

Electric shock may be expected to have a more pronounced effect upon men employed in and around foundries than in many other industrial undertakings. Foundries, steel mills and furnaces call for intensive effort and great physical exertion. The mode of living of the men working in these places is such that they tend to become particularly susceptible to shock; they are hot, dirty and perspiring.

Electric shock under these circumstances may be expected to be the more serious, because the human body becomes a better conductor as moisture of the cutaneous and subcutaneous surfaces increases. It becomes, therefore, particularly important to keep electrical apparatus and circuits covered and prevent men from coming in contact with potential.

The voltage around the furnace is comparatively low. But grounds and other shocks of about 100 volts may cause men to stumble and injure themselves as the indirect result of electric shock.

Electric furnace frames should be thoroughly earthed, so that the exposed metal is at ground potential at all times. The insulating properties of refractories decrease as their temperature increases and this has been the result of many mysterious shocks. The heavy current fluctuations that occur when melting down cold scrap also result in induced voltages that have caused trouble. These can be prevented by the grounded furnace frame.

Another place where shock may be expected to occur is around the conductors leading to the electrodes. Abrasion and physical wear and tear tends to wear through the insulation and expose the copper. Many furnace operators employ specially heavy insulation here.

The effect of mysterious shocks around a furnace, their effect exaggerated because of the ignorance of the men and their hot condition, is psychological as well as physical, and will do much to interfere with normal operation of the equipment.

Live circuits always indicate danger and the danger is more real when the men are not familiar with things electrical and when the use of electricity is merely incidental, as when the output of steel is the all-absorbing purpose. This means, of course, that rigid rules and their religious enforcement are imperative. Rules should be simple and complete.

Transformer Substations.

Most central-station companies appreciate the necessity of keeping high-voltage apparatus protected against accidental or intentional contact and only accessible to certain authorized persons.

Method of Carrying Away Fumes from Non-Ferrous Furnace.

Yet it is not uncommon to find the same or similar apparatus in industrial plants exposed and within reach of anybody and everybody, with perhaps only a barrier placed in the way.

Apparatus such as transformers, oil switches, etc., should be isolated not only for reasons of safety but to prevent interruption of power supply through ignorant and malicious interference.

The central-station companies have perfected many admirable types of industrial substations that protect persons as well as equipment and service. These substations usually permit only the utility representative to enter, while fuses or

Safe and Serviceable Type of Industrial Substation.

All high-voltage apparatus is locked away and can be reached only by the central-station men. The factory electricians can, however, control the low-tension side of the transformers, renew fuses, read meters, etc.

switches located on the premises of the customer permit the customer to shut off power on the low-tension or secondary side of the company's substation.

The situation is somewhat different with the electric furnace, however, because the desirability of having the transformer as near to the furnace it serves results in many cases in each furnace having its own transformer or transformers. This means that precautions that are justifiable and economical in the large centralized installation cannot be practiced where there are several installations scattered around. The basic requirements of each are the same nevertheless and should be recognized; all live parts should be protected from accidental and malicious contact, and only authorized persons should be allowed to have access to control mechanisms. Metallic wire fences serve well for this purpose. They are not expensive, they are economical of space, they are not flammable, and they withstand the rough treatment.

Where the transformer is out of sight a master control switch should be close to the furnace, so that the man in charge can immediately open the circuit. Likewise, in cutting in a furnace, it should be done, finally, directly at the furnace and not from a distance or out of view of the furnace. Such arrangements prevent accidents and delays.

One case with which the writer is familiar emphasizes the absolute necessity for having one man in charge and of having the control at the furnace. Repairs had been made to a furnace and just before starting up again one of the men entered the furnace for some reason. Meanwhile another man had gone to the substation and closed in the circuit. The result was that the man in the furnace was fatally burned. It later materialized that neither the man killed nor the man who accidentally killed him understood

things electrical nor were really conversant with the English language.

Every switch controlling a furnace should be locked open when the furnace is not in use or when repairs are under way. Only in this way can accidents be properly guarded against. Hold cards should be used in the substations proper when repairs are under way at the furnace. But hold cards are practically worthless at the furnace because men simply will not bother with them; they are easily blown away or torn off. The locked master switch is the only safeguard.

Dangers from Water.

Every foundryman realizes the need for keeping moisture and liquids away from metal charged into a furnace and from the furnace. Usually the charge is dried before being put into the furnace. With the electric furnace, on the other hand, water is taken to the furnace.

Water is used to cool the electrodes, the water being passed through stuffing boxes in some cases and in other cases actually flowing through the electrodes. While the latter arrangement is the more effective mode of cooling, perhaps, it is also the most dangerous. Cases have arisen where the electrode has burnt down through long usage until the water used for cooling entered the furnace, where it immediately became superheated steam.

Such an occurrence is similar to an explosion and is very dangerous. If water is to pass through electrodes, great care should be exercised that the electrodes are not allowed to be worn down too close to the water chamber. With stuffing boxes this danger is not present. That water is in close proximity to the furnace itself constitutes a danger which calls for continual care.

Protecting the Eyes.

The eyes of workers around electric furnaces require protection against three different conditions, namely: (1) the electric arc, (2) the intense heat, and (3) burns from explosion and flying particles.

The use of goggles is the best safeguard against injury to the eye, immediate and ultimate. The ultra-violet rays of the electric arc can be combatted by the use of dark glasses. The infra-red rays due to the heat can be combated by sage-green and gold-plated glasses. The Bureau of Standards has published valuable data upon the glass best suited for different conditions. Good glasses are expensive, but they are a good investment.

In using goggles the greatest difficulty is to make the men understand their importance. Each man should be furnished goggles and exchange between men should not be allowed because of the possibility of disease being spread in this way. Periodic cleaning and sterilization should be done by the employer.

In purchasing goggles, the proper color of glass should be chosen at the beginning because if the cobalt-blue glass so often used is bought it is very difficult to make a change later. Cobalt-blue is not effective in providing the protection needed although, be it said, it seems to be the color most widely used. The goggles chosen should have their metallic parts protected by leather, tubing or other non-conducting material so that the heat will not make their use unpleasant.

Steaming of the glasses is a very common reason advanced for not using goggles, and a good one. Sweat pencils and pencils of the glycerine type prevent steaming. Sweat bands around the forehead also reduce the amount of perspiration that can trickle down the glass and into the eye.

Goggles are a good investment and wearing them should become a habit. Safety talks and general education on the value of goggles to protect against injury and the use of proper goggles for minimum discomfort and disability will do away with the usual disregard and disfavor in which the goggle is held by the average electric furnace operator and foundryman.

METHOD OF MANUFACTURING CARBON ELECTRODES.

Ingredients Used for Amorphous Electrodes and Manner in Which They Are Treated to Form Finished Product.

The pioneer work in the manufacture of carbon electrodes was done by a Frenchman, Carré, about 1876. At that time, however, the principal demand was for use in electric arc lights. The chief raw materials used are coke, charcoal, anthracite, lamp black, retort carbon, tar coke, petroleum coke and graphite. In some cases extensive equipment is required for graded crushing, grinding and screening. After crushing the material is mixed with the binding medium, usually tar or pitch, and then kneaded or mixed in steam-jacketed mixers. Before mixing, however, the raw materials are subjected to calcination to remove gases and oily substances. The material is then pressed, sometimes in extremely powerful presses (according to the size of the electrode) to the form required. Roasting and coking processes are then applied to the pressed pieces in tunnel kilns or in Mendheim furnaces. The electrodes are placed into square or round chambers and packed with carbon dust to exclude the air during baking, which lasts from 6 to 12 days for smaller pieces and from 10 to 16 days for larger ones. During the early part of baking the tar oils in the binding medium distill off, following which the binding medium cokes and the entire mass slags. Great care must be employed in heating the electrodes uniformly in order to avoid undue stresses. The following values for the physical and chemical qualities of amorphous carbon electrodes are from a German source:

Specific weight	1.50-1.55
Specific resistance at cross-sections of from 25 to 3,000 sq. cm	45 to 100 ohms
Electrical coefficient of temperature of from 25 to 900 deg. C	0.000318
Specific heat at 100 deg. C	0.18-0.22
Compressive strength	230-410 kg. sq. cm.
Bending strength	51-81 kg. sq. cm.
Heat extension from 0-700 deg. C.	26% of initial value
Heat conductivity for a cube of 1 cu. cm. at temperature falls from 130-20 deg. C.	0.24 heat unit hr.
Ash content	2.5 -3.0 %
Phosphorus	0.45-0.53%
Sulphur	0.91-1.10%

Transformer Equipment for Electric Furnaces

Ratings of Transformers — Mechanical Forces in Windings — Construction Details—Use of Reactance Coils With Furnace Installations — Features of Their Construction and Application

By C. B. GIBSON

Industrial Department, Westinghouse Electric & Manufacturing Co.

Furnace transformers are different from other power transformers, chiefly because the secondary voltages are comparatively low, and, therefore, for the same capacity, the secondary currents are comparatively high. The fluctuating nature of the load is such as to require better bracing of the coils than is required of transformers for the ordinary industrial load.

As a class, furnace transformers are built for primary voltages from 2300 to 22,000 volts, and generally step down to a secondary voltage in the neighborhood of 100 volts. They are built in sizes from 100 to 4000 kv-a. single phase, and from 300 to 7500 kv-a. three phase, and for standard frequencies. All transformers are oil insulated and are either self or water-cooled, depending upon the requirements. It is recognized that there are definite fields of application for each type of transformer construction. The smaller transformers are often of the core-type construction, while all of the larger furnace transformers are of shell-type construction.

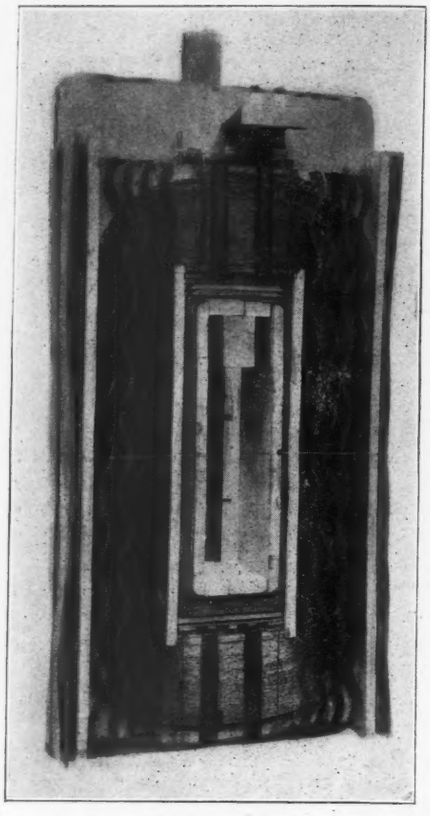
Rating of Electric Furnace Transformers.

In general, transformers for electric furnace service are rated on a basis of 55 deg. C. rise continuous, which is in accordance with standardization rules of the American Institute of Electrical Engineers. Furnace transformers should be capable of withstanding a momentary short-circuit on the low-voltage terminals with full rated voltage impressed on the primary winding.

Where taps are required on furnace transformer windings, their capacity is specified in terms of the normal rating. If a tap is supplied

Bank of Oil-Insulated, Self-Cooled, 11,000-Volt Transformers Aggregating 1500 Kv-a. Rating, Which Supply Energy for Two 6-Ton Furnaces.

to obtain a lower voltage than the normal rated voltage, and the low-tension current is to remain constant, the kilovolt-ampere input is then correspondingly reduced. However, if full kilovolt-ampere output is required when operating at a lower voltage, it requires an increase in the size of the winding in order to carry this increased secondary current. It follows that when taps are required they should either be specified as for "reduced capacity" or "full capacity." The transformer having reduced capacity taps is, of course, the smaller and less expensive, and is used with most furnaces. Primary taps to give secondary voltages higher than normal are inherently full capacity taps, because in this case the secondary current is reduced for normal kilovolt-ampere output.



Pancake Coil Showing Spacing Strips and Fullerboard Barrier.

Mechanical Forces in Transformer Windings.

In all transformers current-carrying conductors are subject to a mechanical force which is caused by repulsion or attraction between their magnetic fields, and this force is proportional to the square of the current value. The windings of the furnace transformer, as well as all low-voltage leads, are acted upon by enormous mechanical forces which tend to separate and distort the transformer coils and to displace the conductors to the furnace. Rapid fluctuations in load, such as those caused while melting down a cold charge with the arc furnace, subject the current-carrying conductors to violent and suddenly applied stresses which tend to loosen wedges, pins and coil bracing within the transformer. With a weak construction this would result in short-circuited coils. The shell-type wedges rigidly between the iron legs of the core all current-carrying conductors, so that vibration or movement of the coil is impossible.

Shell-type transformers are inherently transformers of low reactance. High reactance is not necessary in all makes of furnace transformers to protect them against the stresses of short-circuit currents. The importance of maintaining the highest possible power-factor makes it desirable that a transformer with a comparatively low reactance be used. It is desirable to keep the reactance of furnace transformers at a comparatively low value in order to maintain good regulation and high efficiency. This is of particular importance when the transformer is supplying electric furnace loads.

Construction of Electric Furnace Transformers.

The magnetic circuit of shell-type transformers is built up of laminations of non-ageing silicon steel. The individual laminations are carefully annealed after punching and varnished in order to minimize eddy-current losses. The laminations inter-leave at the corners and are rigidly clamped in position between structural steel end frames. Ample circulation of cooling oil is secured around the iron core.

The transformer winding is assembled in groups of high and low-voltage coils arranged symmetrically and spaced accurately so that the impedances of the individual parallel low-voltage coils are equal. Both high and low-voltage coils are arranged in a vertical plane with vertical ducts between adjacent coils, through which cooling oil has practically unrestricted flow. By this means efficient and uniform cooling is secured. The spacers in the cooling ducts between the coils consist of long, wavy strips, so that no one turn is ever covered by a spacing strip except for a very short length. In this way the coils are effectively braced.

Each low-voltage coil consists of a number of insulated copper conductors in parallel. By this means eddy-current losses caused by the leakage of the magnetic field are reduced to a minimum.

10,000-Kv-a., 120,000-60,000-Volt, High-Tension, 13,200-Volt Low-Tension, 60-Cycle Transformer.

The several low-voltage leads are brought straight up from the tops of the low-voltage coil through the tank cover. Owing to the arrangement of the coils within the winding, the low-tension leads are automatically interlaced in positive and negative order.

Each coil is pressed to exact dimensions in a former and is then dipped in varnish and baked. The insulating treatment binds the turns into solid coils and the process is repeated a number of times until a hard glossy finish is secured. No tape is used on the outside of the transformer coils, so that heat is readily transferred to the cooling oil, and in this way hot spots are eliminated. After assembly the transformer is dried in a vacuum and thoroughly impregnated with oil.

Method of Obtaining Variable Voltage.

If a variable voltage is required at the furnace it is obtained by changing the taps on the high-voltage winding. Circuit-breakers are generally used to accomplish this, the switching always being done on the high-voltage side, since the heavy currents on the low-voltage side would require very large and unwieldy switches. In addition, the heavy current taps from the low-voltage winding could be made only with great difficulty. Switching on the high-voltage side is usually accomplished under load, and voltage surges which tend to break down the high-voltage winding may be set up. For this reason, reinforced insulation is always necessary on all high-voltage taps where switching is to take place under load. Where several low-tension voltages are desired, it is customary to bring the high-voltage taps from the center of the winding so that the winding may be kept balanced. However, with lower primary voltages the taps are located at the end of the coil winding.

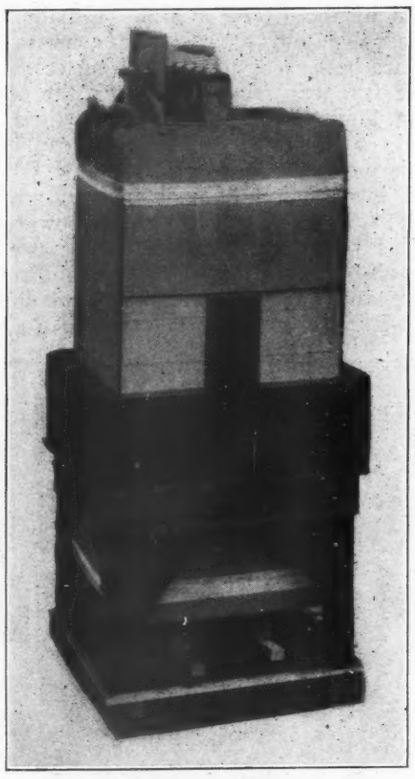
The use of a single, three-phase unit will, in general, be preferable to the use of three single-phase transformers. Three-phase furnace transformers are thoroughly reliable and represent a saving in price, weight and floor space and show higher efficiencies than three single-phase units of equal capacity.

Whenever possible, transformers operating three-phase should be connected in delta on the low-voltage side. This permits of a more nearly normal transformer design, since the current per phase will be less and the voltage per phase greater than when a star connection is used on the furnace circuit.

A furnace transformer should be specified for normal reactance. The reactance desired for stabilizing the furnace arc (approximately 30%) is usually inherent in any furnace installation.

Use of Reactance Coils in Furnace Installations.

Reactance coils or reactors, as furnished for electric furnace installations, are essentially for power-limiting or arc-stabilizing purposes. Their object may be to protect the system to which the furnace is connected from damage by limiting the current which will flow on short-circuit at the furnace. On very small capacity furnaces, where the inherent reactance of the furnace bus layout may be small, a reactor is sometimes necessary to stabilize the arc. Equal protection is provided against short-circuit whether the reactance coils are designed to be inserted in the primary or the secondary side of the transformer. With the large mass of conductor required on the secondary side, reactors are, in general, less expensive when designed for the primary or high-tension circuit. When inserted in the primary circuit they will perform the same functions for arc stabilizing as when inserted in the low-tension leads. In either case, the reactance of the coil will add directly to that of the low tension leads and furnace transformer. A single three-phase reactor is, in general, cheaper than three single-phase units.



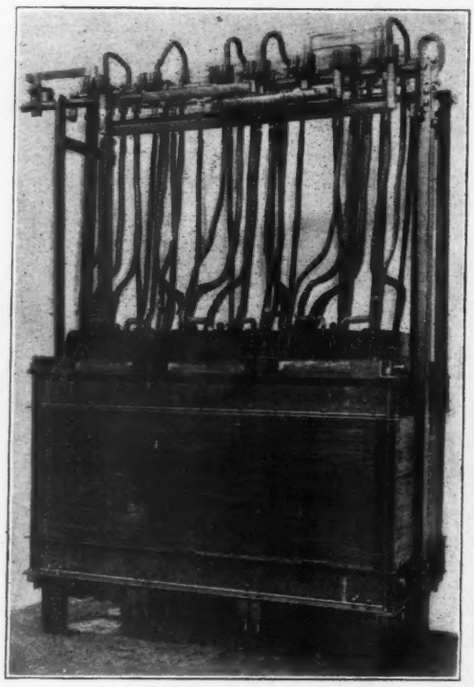
1500 Kv-a. Single-Phase Transformer, Showing Core Being Built Around Winding.

Reactance coils are rated to carry the normal full-load current required to supply the furnace transformers. They are given either a continuous rating or a short time rating, depending on the service required of them. It should be remembered that the inductance upon which the ohms reactance depends is proportional to the square of the number of turns in the coil. A reactor of ten turns total, having a tap at six turns, will have its percentage reactance reduced in the proportion of 100 to 36 in changing to the lower tap. This is a point to be noted where several reactance values are secured by switching to different reactor taps. In general, on an iron core reactor having a continuous magnetic circuit, it is not permissible to short-circuit part of the winding with the remaining part of the winding excited.

Reactance coils may be built either with an iron or air core. The presence of iron increases the inductance of the coil so that reactors having an iron core are relatively smaller and less ex-

pensive than those having an air core. In power-limiting reactors, however, it is not possible to utilize iron in reactor construction, because after the iron has reached a point of magnetic saturation the reactance drop no longer increases with increasing currents. This means that on short-circuit with the very heavy current that will flow, an exceedingly large cross-section of iron is required to prevent saturation and to secure the benefits of the iron material. Usually this is impracticable and the air-core construction is therefore better for power-limiting service. In electric furnace practice, however, the power is usually limited to not more than three times normal, so that iron core reactors can be used for this service.

The introduction of reactance in any form into the furnace circuit lowers the power-factor. For this reason reactors should be used only when absolutely necessary for stabilizing the furnace arc, or for obtaining special and temporary furnace operating voltages. An arrangement of the low-tension bus will usually introduce any desired amount of reactance into a furnace circuit and may be so proportioned that the total of inherent transformer reactance plus low-tension bus reactance will be the minimum required for satisfactory operation.



3000-Kv-a., 12,000-Volt High-Tension, 2300-Volt Low-Tension, Three-Phase, 60-Cycle, Oil-Insulated, Water Cooled Transformer.

RELATIVE HEAT CONSUMPTIONS FOR BRASS MELTING.

According to a recent statement before the Association of Iron and Steel Electrical Engineers one ton of brass can be melted electrically with 300 kw-hrs. input, by 55 gallons of oil containing 155,000 B.t.u. per gallon, or by 17,000 cu. ft. of gas containing 600 B.t.u. per cu. ft.

Safety, cleanliness, flexibility, reliability and convenience and rate of production are all in favor of the electrically produced heat.

SELECTION OF ELECTRODES FOR FURNACE OPERATION.

Use of Proper Type of Electrode an Important Factor in Successful Operation of Electric Furnaces.

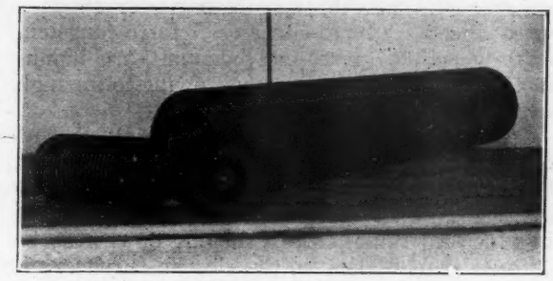
The great increase in the electric furnace industry in the past five years has brought about many problems of interest not only to the actual operators of these furnaces but to prospective electric furnace users and to the engineers interested in their installation and equipment, according to a statement of Atwood B. Oatman, Acheson Graphite Co., Niagara Falls, N. Y. The rapidity of this growth can probably be better understood when it is realized that in 1915 there were only 41 electric furnaces in operation in the United States and 213 in the world, while in 1920 it is estimated that there were 490 electric furnace installations in the United States and 1390 in the world. This does not include the many in the world. This includes only those in the iron and steel industries. A large part of this increase is due to the advent and rapid adoption of the electric brass furnace, which is also used for the melting of other nonferrous metals. There were none in use in 1915, but it is estimated there are now 261 of these furnaces in the United States alone.

Not the least of the problems which have arisen through the growth of this industry is what is the best type of electrode to be used on the different furnaces. There are at present two kinds of electrodes available, the Acheson or graphite electrode, and the amorphous carbon electrode. The former, so called after its inventor, Dr. E. G. Acheson, is made by treating high-grade specially made carbon electrodes in electric resistance furnaces until the whole mass is transformed into solid, pure graphite. The amorphous carbon electrode is made by mixing coal or coke with a hydrocarbon bond, such as pitch or tar, and, after the electrode has been formed by tamping the mass in molds or extruding in hydraulic presses, baking it until it is thoroughly carbonized.

The ideal electric furnace electrode should have many attributes, the chief of these being high electrical conductivity. The higher the electrical conductivity of the electrode the smaller will be the electrode which can be used, which means that the refractory life both in the roof and side walls of the furnace will be greater. The smaller electrode also presents a smaller surface to the oxidizing influences of the furnace. Another attribute is high temperature of oxidation, which insures a low electrode consumption, as the electrode will not be so readily attacked by the oxygen liberated from the charge during reduction and refining.

It is necessary that electrodes be provided with some effective means of joining, so the stub ends will not be wasted nor the operation interrupted for replacing electrodes. For this reason a straight nipple or screw connection has been

adopted almost universally. The Acheson electrode can be readily machined on a lathe with ordinary tools so that a tight-fitting, perfectly conducting joint can be made. Amorphous carbon electrodes are not easily machined, so the



Graphite Electrode, Showing Method of Making Joint.

threads and nipples are molded, making the use of a graphite paste necessary to reduce the electrical resistance and consequent power loss at this point.

The amorphous carbon has greater tensile strength than the Acheson electrode, but at the same time it is more brittle. The graphite electrode is usually denser and slightly softer so that the shock when scrap falls against the electrode is more easily taken up. The ability to withstand these unavoidable strains is necessary, so that the electrode will not break, and cause interruptions which greatly increase the cost of production.

All electric furnaces can be easily adapted to the use of either kind of electrode. Accordingly, the furnace operator should not only consider the process in which he is interested and the type of furnace, but should also go into the question of the best possible electrode very carefully. Probably no one item can so seriously affect the operating cost of an electric furnace, and the use of the correct or incorrect electrode may mean the success or failure of the proposition.

ELECTRIC FURNACE INDUSTRY HAS WIDE SCOPE.

Possibilities in Fields of Steel, Steel Alloys, Cast Iron and Malleable Iron Pointed Out—Electric Furnace Supplanting Other Methods.

By Frank Hodson.

President, Electric Furnace Construction Co., Philadelphia.

During the war the electric furnace not only proved that it offers many advantages in steel making over the older processes but also demonstrated that in making many classes of steel it is an absolute necessity.

Steel of any composition made by other processes may be duplicated in the electric furnace, and the process lends itself further to the manufacture of steels which could not be attempted in the crucible, Siemens, open-hearth, Bessemer and allied processes. Illustrating this point, it is perhaps only necessary to point out that practically all low-carbon steel containing from 7 to 14% of chrome (generally known as "rustless steel") is made in the electric furnace, using low-grade high-carbon ferro-chrome and common steel scrap, the elements carbon, sulphur and phosphorus being satisfactorily eliminated, and a very sound steel produced.

The new electrical resistance alloys of nickel chromium, used so extensively for electrical ovens, heaters, dryers, etc., are made exclusively in electric furnaces.

High-Speed Steel and Special Alloy Steels.—The demand for this class of steel has multiplied itself many times in recent years, and the electric furnace has solved the problem of its manufacture. The old method of melting and refining in crucibles failed to meet the demand for quality and uniformity; the analysis from each pot was found to vary considerably, and the practice of teeming several pots from one ladle or ingot mold (on the principle of plus and minus errors cancelling one another) has been adopted in many cases to overcome this objection.

When it is considered that a better and uniform quality of steel can be obtained from the electric furnace from cheap scrap materials at a much lower capital and operating cost than by the crucible process, it is not difficult to prophesy which process will ultimately survive. In view of the severe competition in high-speed steel and special alloy steels, the makers cannot afford to be second best, and the electric furnace offers the only certain method of obtaining and holding the market.

The electric furnace is considerably cheaper than the crucible process, and firms who had previously operated crucibles—in one case for 120 years—state the quality is more reliable and superior to the older crucible process.

The smaller furnaces seem to give the best results on high-speed steel, but for special alloy steels for motors, aeroplane parts, ball bearings, magnets, and all special purposes furnaces of up to 15 tons have been installed. The refining can be carried out to a very fine degree and a very cheap base material can be used, such as turnings and crop ends, the necessary alloys being added during melting operations. It should be noted that scrap containing valuable alloys, such as nickel, chromium, vanadium, etc., can be melted without loss of these elements.

Steel Castings.—Many manufacturers that sell their steel swarf and scrap, cast-iron borings, etc., at very nominal prices, and purchase all their steel castings, could profitably install electric furnaces and make their own castings from scrap. The charges can be made up entirely of scrap and turnings, no expensive raw materials being necessary. The melting loss is almost negligible, while in other processes it is from 10 to 15%.

Steel from the electric furnace is finished off under a reducing atmosphere of carbonic oxide and a slag out of which the metallic oxides have been reduced, and is singularly free from blowholes when properly cast. This is due to the elimination of the gases that molten steel usually holds in solution. The ease with which the molten steel can be poured into small and intricate castings, flowing smoothly, like cream, and setting perfectly quiet in the molds, is largely due to its purity.

For small, light castings, furnaces of not more than 2 tons are recommended; steel of such low-carbon content has a high melting point and must

be cast at a very high temperature, and, though the temperature is easily obtained in the furnace, difficulties occur in handling large quantities of such hot metal in ladles if a large number of castings are to be made. For small, mild-steel castings, many of which have proved a better substitute for malleable iron castings, smaller furnaces are recommended, and several firms have installed furnaces of 0.5-ton capacity to melt steel for small engine parts of motor cycles and motor cars instead of using stampings. The process can be worked in conjunction with hot metal from a cupola, Siemens, or other furnaces.

Alloy Steel Castings.—A very large field is now being opened up for alloy steel castings. One has only to consider the immense increase of alloy steels the last few years to see the possibilities in alloy steel casting. Due to the fact that electric steel can be poured at a much higher temperature in a still or dead condition, it has become possible to produce intricate thin section castings with regularity and without high percentage of rejections. As a result, electric steel castings are now used in many fields not open to steel castings heretofore.

Iron Castings.—It is not anticipated that the electric furnace will be used normally for the production of cheap iron castings, but, as explained in connection with steel castings, the molten metal from the electric furnace is singularly free from occluded gases and can be poured with ease into small and intricate castings. There is considerable demand for high-quality iron castings for motor-engine cylinders, pistons, etc., where strength, reliability, and uniformity are absolutely essential. For this work the electric furnace is ideal and has recently been adopted by a number of firms for this purpose.

A large firm in the South is mixing its blast-furnace and cupola metal in the electric furnace and giving it a short heat treatment and refining. Results are said to be very encouraging, resulting in much less waste and rejections and better iron castings. This is one of the biggest fields for the electric furnace. Several firms are melting up iron turnings and cheap scrap into castings and pig iron. Where pig iron and coke is costly and power reasonable there is a large demand for this simple melting of iron scrap.

Malleable Iron Castings.—These are high-carbon iron castings which have been treated to a tedious and expensive annealing process, the effect being that of decarburizing the outside surface. It has been recently recognized that electric steel castings can be made just as cheaply as malleable iron castings, while the physical properties of the former are infinitely superior and more reliable.

Where the extra strength is required, electric steel castings are rapidly supplanting malleable castings. One or two large manufacturers of malleable iron are also giving their product a short final treatment in large electric furnaces. The quality of the metal is considerably improved at slight cost. The expensive lengthy annealing of malleable is largely eliminated by using electric furnaces.

Addition of Alloys to Bessemer or Siemens.—The electric furnace is also used for working in conjunction with the open-hearth and Bessemer plant for the purpose of melting alloys, it being much more economical to make alloy additions in the molten form either in the furnace or in the ladle, and the electric furnace provides the ideal method of making such additions.

Ferro-Alloys.—All the high-grade alloys—ferro-silicon, ferro-chrome, ferro-tungsten, ferro-vanadium, ferro-molybdenum—are manufactured in the electric furnace, owing to the high temperatures that are necessary.

Hot-Metal Process.—This process can of course be used by tapping out molten metal from fixed Siemens O.H. furnaces, Bessemer converters, metal mixers or any other form of furnace in which the initial cost of melting down may be cheaper than if done in the electric furnace. It is generally thought that the future of the steel industry lies in this duplex process, and it certainly offers a very promising field to firms who are prepared for the large outlay of capital involved.

RAILROADS MAKE TENTATIVE PLANS FOR ELECTRIFICATION.

Present Condition of Money Market Proves Big Hindrance to Commencement of Work in All Sections of the Country.

Manufacturers in the electrical industry field believe there will be a pronounced movement toward the electrification of railroads at the end of another year. Railway men tell the manufacturers, when approached on the subject, that they are trying to accomplish two objects before turning to the electrification problem.

They are first trying to relieve the shortage of rolling stock that affects every railroad in the country and are also trying to effect the restoration of the former operating efficiency that obtained under private management before the railroads were taken over by the government.

In this connection manufacturers of electrical equipment are endeavoring to make the railroad companies realize that it would be far better to start a program of electrification now, as operating efficiency can undoubtedly be greatly increased thereby, and the railroads also would not then be obliged to scrap new equipment that would become obsolete through electrification.

Railway men are showing a keen interest in the possibilities of electrification, though few, if any, are at the present time ready to begin the work of electrification. A number of eastern railway executives are making extensive inquiries and engineering departments have collected a great deal of preliminary data which the electrical companies have been asked to examine. The equipment manufacturers say they are prepared to handle all the railway business that may be reasonably expected and that they can continue to keep abreast of the demand.

As in all other lines of industry the greatest deterrent to immediate electrification of many railroads is the present money situation. Big financial interests behind railroads that would profit greatly from electrification are not encouraging them to put their money into an investment which will yield an ultimate, but not an immediate return.

EDITORIAL COMMENT

The Furnace and the Electrical Industry

Step by step the experiments of the century have developed the electric furnace from a crude battery-operated arc to its present established position as a real factor in the commercial production of materials of many kinds. Progress was slow for a long period of time, being limited by the lack of a demand for product and by a lack of a suitable source of power. Rapid development of the railroads produced a demand for iron and steel products on a large scale, but the electrical industry was then undeveloped and other methods of metal production and refining were established, both financially and technically. With the demand for great bulks of iron and steel there also arose a demand for small quantities of material of exceptional qualities to be used for cutting tools and other purposes where quality was pre-eminent and price a secondary consideration. Here was a field in which the electric furnace was particularly fitted to compete. However, the electric furnace had already been adapted to the manufacture of aluminum and carbide, and some quite large equipments had been produced.

The electrical industry developed to a point where it could be relied on to supply power in almost any desired quantity and at very low prices. Manufacturers and users of the furnace in aluminum and carbide production and in experimental work were quick to see the relation between a reliable power supply and a growing demand for iron and steel products of superior quality. The automobile and aeroplane industries have been prominent factors in creating the demand for quality products, and of themselves offer a wide field to the electric steel industry, in addition to the demand which they create by their demonstration of the value and economy attending the use of materials of the best grade. Each new success in the production of greater outputs and better materials has resulted in still greater demands and in the opening of new markets, until now it is practically impossible to predict what the future will bring. The furnace industry has gone through the period of slow development, while waiting for power and a market for its product, and is now broadening out and preparing to assume a place in the industrial world commensurate with its merits.

With the market for products established and an ability to produce a consistent output, there is nothing to hamper the growth of the furnace business except its physical ability to expand. The financing of new installations, the manufacture of equipment, the training of men and the establishment of marketing facilities all take a certain amount of time, and comprise the main factors that make the growth of an industry gradual rather than sudden.

The central-station industry is certain to secure a large volume of new business as a result of the development and increasing use of the furnace. With one central station now supplying nearly 4,500,000 kw-hrs. per month to its furnace customers, and the available field hardly touched, it is evident that the total business in sight and to be had in the near future will play a prominent part in the expansion of many phases of electrical development. Manufacturers, through direct sales; contractors, through services, and central stations, through the supply of energy, will all be called upon to share in the prosperity of the new business.

A Working Definition of Polyphase Power-Factor

From the time when alternating current came into general usage, power-factor has been recognized, and many ways of alleviating the deleterious effects of low power-factor have been devised.

Nothing stands still, and this is equally true of power-factor. Low power-factor has assumed a somewhat new significance as conditions have changed, until at the present time the old definition of power-factor and the old ways of measuring it have lost much of their usefulness. We all know the definition of power-factor when applied to the single-phase circuit or the balanced polyphase circuit. But how about the badly unbalanced polyphase circuit?

That rates should include a clause introducing power-factor so as to be a factor in the energy rate is now recognized. Many companies have already adopted a power-factor clause. At least one large central-station company has long been wanting to make it compulsory that customers use a synchronous motor when the motor capacity is 100 hp. or more.

Central-station companies have been hampered because of the lack of a working definition of power-factor for the unbalanced polyphase cir-

cuit that would permit them to stipulate properly and meter scientifically and so not penalize their customers unjustly.

Electric furnace loads, welding outfits and the four-wire, three-phase distribution networks as well as other forms of load have contributed to the need for a better understanding and universal appreciation of the true significance of polyphase power-factor with unbalanced loads. In fact, it is these types of loads, the need for more equitable power rates, and the perfection of the synchronous motor which, in turn, permits compensation as well as prevention, that have combined to bring the question of polyphase power-factor to the fore.

The American Institute of Electrical Engineers and the National Electric Light Association have recognized the need for developing a working definition of polyphase power-factor for unbalanced circuits and the urgency of placing this matter before the engineers of the country. The result of this was seen at the A. I. E. E. convention this summer, when the whole subject was taken up in a very thorough manner that augurs well for a better understanding of the problem. In all, eight papers on the subject of power-factor were presented, dealing with the definition, the representation and significance of polyphase power-factor in unbalanced circuits.

It is, indeed, hoped that before long the customer will be equitably penalized for low power-factor and profit by maintaining high power-factor, and that this will become the rule rather than the exception, so that eventually low power-factor will be taboo instead of being tolerated. After all, low power-factor is not very excusable.

Developing the St. Lawrence Waterway

Opposition to the development of the St. Lawrence river so as to provide a deep-water route from the Great Lakes to the Atlantic Ocean seems to have practically ceased. At meetings held in connection with the project at Detroit and Cleveland recently opponents of the proposition, who were largely in evidence at earlier meetings, were conspicuous by their absence, and not a word of objection was heard to the development.

Naturally the states and cities touching the Great Lakes are in favor of the deepening of the channel of the St. Lawrence. Apparently so is every other section of the country, with the exception of a few of the Atlantic seaboard cities. New York City, in particular, has exhibited fear for its industrial supremacy.

Opposition from this section at the earlier meetings on the plan was strong, but at later meetings little has been heard from those who do not favor the plan. Without referring to the selfishness of such an argument as fear for industrial supremacy, such fear seems groundless. Any loss resulting from the diversion of traffic which would come from making the Great Lakes arms of the ocean, in effect, would be more than offset by cheap power, and cheap water transportation of steel, copper, wool, foodstuffs, etc.

Coupled in with the development of the St. Lawrence river, which would be a joint operation by the United States and Canadian governments, is the building of the new Welland canal connecting Lake Erie and Lake Ontario, work on which is in progress under the direction of the Canadian government.

Public utility companies, particularly in the eastern states, are interested in the St. Lawrence development. While the deepening of the channel means a waterway to the ocean for Great Lakes commerce it would also mean the development of a great amount of water power in the St. Lawrence river.

Engineers representing the United States and Canada are now working on plans and estimates for both the deepening and water-power projects. It is said that those who have given the matter thought are convinced that the improvement can be accomplished best by means of a series of dams which will "drown" the rapids in the St. Lawrence river, and turn the river into a series of ponds, and incidentally develop the St. Lawrence water power to six times the present development at Niagara Falls.

This would mean that utility companies operating throughout New York, northern Pennsylvania and all of the New England section would be in a position to obtain electrical energy from the hydroelectric plants that would be built on the St. Lawrence river in the same manner that towns in Canada 250 and 300 miles distant from Niagara Falls obtain power from the Hydro-Electric Commission of Ontario through the plants of the commission now in operation at Niagara Falls.

Electrical energy from the St. Lawrence hydroelectric plants would also be available as a source of additional supply to the proposed Boston-Washington super-power zone, the possibilities of which is now being investigated by a government commission.

The economic value of such an improvement to the United States as a whole—the Middle West in particular—and the utility companies of the sections cited would be enormous. It would result in increased growth from which the Atlantic seaboard would profit greatly in commerce and industry. The objections of the few in this instance should be disregarded in favor of the benefit that would come to the many.

THE WEEK'S NEWS

Reports of Important Meetings, Developments and Other Happenings of the Electrical Industry and Its Allied Interests

PRIORITY RULE AIDS UTILITIES IN OBTAINING COAL.

Slight Improvement Shown in Situation Throughout the Country Except in Illinois Where Strike Closes Down Mines.

Assigned cars for public utilities are now appearing at the coal mines, in conformity with the recent order of the Interstate Commerce Commission, though as yet they are comparatively few in number. In this way the utilities are given priority rights along with the railroads, as the order provides that the assigned cars shall not count as a part of the mine's quota for commercial use.

For the first time in the present emergency the past week has seen a noticeable improvement in the supply of cars in the different bituminous coal centers. This is particularly true of the central Pennsylvania fields and is generally ascribed to the order restricting the use of open-top cars to the carriage of coal.

In the Middle West the situation was clouded somewhat by a strike of the Illinois miners, but this did not result in such a large reduction in the amount of coal shipped as was expected, because the railroads, as soon as the strike went into effect, rushed empty coal cars from Illinois to Indiana mines, with the result that the latter have had practically a full supply of cars for the week.

The New York City industries and inhabitants will spend $10,000,000 more for coal this year than last, according to a statement by John W. Lieb, vice-president of the New York Edison Co., testifying before the United States Senate committee that is investigating the coal situation in the east. Mr. Lieb said the increased price would be caused by the coal operators taking advantage of the present crisis to sell "spot" coal at greatly increased prices.

ELECTRICAL EXPORTS MAKE HEAVY GAIN IN MAY.

Total Amounts to $8,952,277, an Increase of $1,234,759 Over the Figures for the Same Month Last Year.

Exports of electrical goods to foreign countries for May showed a large increase over the figures for the same period of 1919, the total being $8,952,277, as against $7,717,518 in May, 1919, a gain for this year of $1,234,759.

For the first eleven months of the government fiscal year, which ended July 30, 1920, the total exports amount to $78,196,464, an increase of $8,474,971 over the 1919 figures and of $28,669,022 over the 1918 eleven months' total. The figures above are taken from the monthly summary prepared by the United States Bureau of Foreign and Domestic Commerce. The following classified figures give the detailed data for May, 1920, compared with the corresponding month last year:

	May, 1920.	May, 1919.
Electrical machinery and appliances:		
Batteries	$ 676,624	$ 516,001
Carbons	129,546	130,982
Dynamos and generators	549,251	257,908
Fans	152,100	201,125
Heating and cooking apparatus	227,227	146,765
Interior wire and cables	791,303	838,188
Interior wiring supplies, including fixtures	341,302	179,931
Lamps—		
Arc	3,817	1,300
Incandescent—		
Carbon filament	5,566	44,157
Metal filament	334,843	434,894
Magnetos, spark plugs, etc.	360,317	291,415
Meters and measuring instruments.	288,021	245,589
Motors	1,132,811	817,118
Rheostats and controllers	43,365	64,478
Switches and accessories	269,794	255,099
Telegraph apparatus, including wireless	41,752	70,296
Telephones	414,838	285,785
Transformers	319,992	326,224
All other	2,869,808	2,610,263
Total electrical machinery, etc.	$8,952,277	$7,717,518

N. E. L. A. NAMES CHAIRMEN OF STANDING COMMITTEES.

Electrical Resources of the Nation Committee to Devote Efforts to Summarizing Future Demand for Electrical Energy.

The first meeting of the newly elected executive committee of the National Electric Light Association was held at the association headquarters, New York City, July 14, at which time President Martin J. Insull outlined the prospective work of the association for the coming year and made several important committee changes.

As one of the results of the changes the work of the following national standing committees was placed under the direction of the Public Relations Section: accident prevention, company employes' organizations, membership, co-operation within the industry, public information, service, and relations with educational institutions.

In continuing the work of the committee on electrical resources of the nation, the scope of the activities of the committee was changed from a post-war basis to a peace basis, the committee being directed to estimate and summarize the total demand for electrical energy during the years 1920-1922, inclusive, and the means at hand for supplying the same; also to estimate the increase in capital expenditures necessary to provide the capacity needed to take care of the demand, and to analyze the relative effectiveness of private and public ownership.

The wiring committee, formerly under the direction of the Commercial Section, was made a national standing committee, with R. S. Hale, Edison Illuminating Co. of Boston, as chairman. The Technical and Commercial Sections will

each elect a vice-chairman of the committee, the remainder of the committee to be chosen by the chairman and the two vice-chairmen. S. Z. Mitchell, president of the Electric Bond & Share Co., New York City, was made chairman of the public policy committee, this committee having an important part in the work of the association this year.

Other committees and the chairmen appointed are: Rate research, Alex Dow, Detroit Edison Co.; constitution and by-laws, W. C. L. Eglin, Philadelphia Electric Co.; membership, Walter Neumiller, New York Edison Co.; electrical resources of the nation, M. S. Sloan, Brooklyn Edison Co.; Doherty and Billings prizes, A. S. Loizeaux, Consolidated Gas, Electric Light & Power Co., Baltimore; electrification of steam railroads, F. M. Kerr, Montana Power Co., Butte, Mont.; finance, Joseph B. McCall, Philadelphia Electric Co.; lamp, Frank W. Smith, United Electric Light & Power Co., New York City; water power development, Franklin T. Griffith, Portland (Ore.) Railway, Light & Power Co.

At a recent meeting of the executive committee of the Technical Section, plans for the year were outlined and 33 committee meetings were scheduled, these being in addition to the regular executive committee meetings. The Commercial Section executive committee met at Association Island, Henderson Harbor, N. Y., during the convention of the Sales Managers' Association and arranged for a series of 26 meetings during the year, in addition to the regular meetings of the executive committee.

PACIFIC COAST SECTION, A. I. E. E., HOLDS CONVENTION.

Papers and Discussion on Suspension Insulators Given Much Attention by Delegates in Attendance at Sessions.

Three papers dealing with suspension insulators furnished one of the main topics at the annual convention of the Pacific Coast Section of the American Institute of Electrical Engineers, held at Portland, Ore., July 21-24, with headquarters at the Multnomah Hotel. About 150 delegates attended the convention, which in the absence of President Calvert Townley, was presided over by Vice-President John B. Fisken, chief engineer of the Washington Water Power Co., Spokane, Wash.

Other subjects discussed at the convention were railway electrification, bridge methods for a-c. measurements, fuel propositions and power-factor problems, the delegates devoting five sessions to the reading and discussion of papers.

The papers on suspension insulators took up all of the first day of the convention, following the opening address delivered by Vice-president Fisken. The first paper was by W. D. A. Peaslee, electrical engineer of the Jeffery-Dewitt Insulator Co., Huntington, W. Va., in which he explained the various phases of suspension insulator design, giving in detail the factors governing rational practice, and discussing the causes of mechanical and electrical failures of units.

Papers on Suspension Insulators.

The second paper was presented by Harris J. Ryan and Henry H. Henline, both professors at Leland Stanford, Jr., University, Stanford, Cal. In this paper the conclusions reached showed that suspension insulator units in common use can be satisfactorily employed for the make-up of insulators for 250-kv. lines, and that an increase in the number of strings in the suspension insulator will permit the use of a limited increase in line voltage. It was also pointed out that static shields in requisite forms will lower the maximum unit voltage duties so as to permit the satisfactory insulation of line for the use of voltages far above 150 kv.

"Electrical Characteristics of the Suspension Insulator at Higher Voltages" was the subject presented by F. W. Peek, consulting engineer at the Pittsfield, Mass., plant of the General Electric Co. In the paper he explained that insulator troubles have been mainly due to cracking caused by expansion of metal parts, cement, etc., and to porosity, and that certain designs with loose-fitting parts have been free from deterioration. He recommended that other designs should be so modified as to relieve them as far as possible from expansion troubles.

The old method of basing everything on electrical tests should be abandoned, declared Mr. Peek. Severe electrical tests are often harmful

Delegates in Attendance at Annual Convention of Pacific Coast Section

and the electrical strength is often secondary to other characteristics. Electrical, mechanical and porosity uniformity tests should be established, in which a small percentage of the product is tested to destruction from day to day to ascertain if it is running brittle or porous or is weakened by firing strains.

The general discussion of the papers on suspension insulators took a wide range. It was opened by M. T. Crawford, Puget Sound Power & Light Co., Seattle, Wash., who described insulators in use on low-voltage lines and gave a brief description of line construction in which pin-type and suspension designs were used. E. R. Stauffacher, protection engineer of the Southern California Edison Co., gave an account of field tests made on insulators on the Big Creek transmission lines of his company, including results of preliminary studies on conductor and insulator installations, and particularly described the double transmission line from Big Creek to the Eagle Rock substation at Los Angeles, Cal.

Should Abandon Old Method of Testing Insulators.

George E. Quinan, chief engineer of the Puget Sound Power & Light Co., Seattle, took up the subject of ceramics, and discussed porcelain and its deterioration when under the effect of electrical stress. He raised the question of just what takes place under such stress, and expressed the opinion that electrical men might study ceramics to good advantage. W. A. Hillebrand, sales manager of the Ohio Brass Co., Mansfield, O., followed Mr. Quinan with an interesting discussion of porcelain, dealing with its composition, porosity, and its importance as a ceramic product in the field of electricity. In the fusing of quartz, feldspar and clay for the production of porcelain, feldspar acts as the binder, said Mr. Hillebrand. In connection with the subject of deterioration of porcelain as an insulating material, Mr. Fisken took the position that it is impossible to produce a kind that is free from porosity and which will not deteriorate.

W. A. Hawley, electrical engineer of the Locke Insulator Manufacturing Co., Victor, N. Y., gave his experience as a user of insulators in electrification work and described the porcelain tests made in the Locke factory. S. C. Lindsay, electrical engineer of the Puget Sound Power & Light Co., said the effect of vibration was a factor in getting a porcelain insulator to stand the test of service.

Suggests A. I. E. E. Prepare Insulator Specifications.

J. C. Clark, engineering specialist of the General Electric Co., suggested that the A. I. E. E. prepare insulator specifications. He said the mechanical requirements are such as to enable the insulator to support the line and that under electrical stress no deterioration can occur in non-porous porcelain. Mr. Peaslee discussed the tension and compression characteristics of porcelain, and indicated that it would stand the electrical test if the process of its manufacture were perfect. He gave as his opinion that most porcelain insulators now being produced were non-porous, would stand the immersion test, would resist flash-overs and not deteriorate.

At the Thursday sessions D. I. Cone, Pacific Telephone & Telegraph Co., San Francisco, presented a paper on "Bridge Methods for A-C. Measurements," while "Railway Electrification" was described by R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul Railway Co., who told of the work in connection with the recent electrification of that railroad and gave in detail the power consumption on the electrified lines in the Rocky Mountain division.

Mr. Beeuwkes submitted figures showing there had been a decrease in operating expenses since the electrification of th railroads a few months ago.

In discussing electrification Mr. Fisken, conceding the practicability and low cost of operating railway trains by electric locomotives, referred to the possibility of other roads being electrified, and put forth the inquiry whether, in future work, the railroads would undertake to produce their own power or would purchase energy from power companies and devote their attention strictly to transportation problems. Mr. Fisken also asked two other pertinent questions, telling the delegates they were angles of the railway electrification development to keep in mind. The first question was: Will companies that electrify their roads in the future adopt a standard voltage, and will energy be alternating or

of the American Institute of Electrical Engineers at Portland, Ore., July 21-24.

direct current? The second question was: To serve Pacific Coast railroad lines will there be a continuous bus line along that coast from which energy will be delivered to railroad feeder lines, and, if so, will it be owned by the power companies or the railroad companies?

In answering the latter question Mr. Beeuwkes expressed the opinion that the Chicago, Milwaukee & St. Paul Railway Co. has a preference for arrangements under which energy would be furnished by power companies. Regarding the adoption of a 3000-volt, d-c. standard as a trolley voltage, he thought matters along that line had not progressed sufficiently to determine whether it was logical or not. A change to 5000 volts as trolley voltage, he explained, would involve higher costs in copper and locomotives. As to the ownership of a possible high-tension bus line he was inclined to think the railroad companies should be in control, to direct maintenance and control substations and switches. He thought more than one railroad system on one bus line would not be desirable.

Others who discussed railway electrification were W. J. Davis, General Electric Co., San Francisco; E. R. Cunningham, Oregon Electric & United Railways, Portland, Ore.; J. C. Clark and G. E. Quinan.

Explains Value of Mill Refuse as Fuel for Central Stations.

Darrah Corbet, of the engineering firm of Charles C. Moore & Co., San Francisco, presented an interesting paper on "Sawmill Refuse, Fuel Oil, and Pulverized Coal." Mr. Corbet explained that while there exists available data on oil and coal there is very little information on mill refuse as a fuel for steam power plants, and for that reason he was devoting his time to a study of sawdust, cuttings and "hog" as types of mill refuse. He described "hog" as the chopped-up, half-crushed blocks and slab cuts of mill refuse, and said while it was hard to handle, requiring large space for storage, it was considered a cheap, satisfactory fuel if arrangements are made for a continuous supply. A valuable phase of the paper was that relating to the heat value of the several kinds of wood. Attention was devoted to the mechanical means of handling "hog" fuel, and the difficulty of getting it out of storage bins and heaps, where it becomes very compact.

The discussion of the fuel subject was participated in by the following: L. T. Merwin, general superintendent of the Northwestern Electric Co., Portland, Ore.; C. P. Osborne, superintendent of power of the Portland Railway, Light & Power Co.; James H. Polhemus, general manager of the Port of Portland; Prof. S. H. Graf, Oregon Agricultural College; H. B. Schoolfield, chief engineer of the Pacific Power & Light Co.; R. F. Hayward, general manager, Western Canada Power Co., Ltd., Vancouver, B. C., and S. C. Lindsay, Seattle, Wash.

At the evening session Thursday a paper on "Use of Special Steels in Pressed-Steel Transmission Line Fittings," was presented by L. R. O'Neill, chief engineer of the Maryland Pressed Steel Co., Hagerstown, Md. This was followed by a discussion of the activities and welfare work of the Institute, during which F. L. Hutchinson, secretary of the A. I. E. E., gave a review of the work of the Institute during the past year. He discussed geographic districts, co-operation with other engineering societies, and the objects of the Federated Council of Engineers.

Delegates Discuss Power-Factor Correction.

On Friday D. M. Jones, of the lighting engineering department of the General Electric Co., Schenectady, N. Y., presented a paper on "Power-Factor Correction on Distribution Systems." Mr. Jones pointed out that the development of the art of distribution of electrical energy has been practically dictated by the developments in electrical energy producing and consuming devices. The demand that distribution systems cover over larger areas has forced higher distribution voltages. The safety of the consumer and lower relative cost of manufacture in the case of most small electrical power-consuming devices has kept the mass of customers' services at a relatively low voltage.

In the discussion that followed the paper W. J. Davis spoke of the synchronous condenser, saying its use was of value in improving regulation, resulting in allowing the use of smaller units in power plants. L. T. Merwin, conceding the prevalence of low power-factor and the necessity for correcting it, wanted to know how the burden of doing so could be passed to the consumer, or, in other words, how could it be incorporated in the rates, on the delivery of a higher percentage of power produced from a given generating unit. Others who discussed the paper were: O. B. Caldwell, general superintendent of the Portland Railway, Light & Power Co.; J. E. Woodbridge, consulting engineer, San Francisco; Prof. H. J. Ryan; R. F. Hayward, Western Power Co., Vancouver, B. C.; H. T. Plumb, General Electric Co., Salt Lake City, Utah; Prof. H. V. Carpenter, State College of Washington, Pullman, Wash; C. A. Whipple, consulting engineer, Seattle, Wash., and W. D. A. Peaslee.

During the convention F. D. Weber, electrical engineer, Portland, Ore., gave an explanation of a new state law passed in Oregon that requires engineers in all branches to register before being allowed to operate in Oregon.

A golf tournament for the John B. Fisken cup took place on Friday afternoon, the trophy going to C. L. Wernicke, Portland branch manager for the Westinghouse Electric & Manufacturing Co. Other entertainment furnished the delegates consisted of automobile rides over the Columbia Highway and a banquet at the Crown Point Chalet.

PACIFIC COAST SECTION, N. E. L. A., NAMES CHAIRMEN.

Lee H. Newbert, president of the Pacific Coast Section of the National Electric Light Association, has appointed the following men as chairmen of the section committees for the ensuing year: R. A. Balzari, of the Westinghouse Electric & Manufacturing Co., chairman of the membership committee; J. A. Britton, vice-president and general manager of the Pacific Gas & Electric Co., chairman of the public policy commit-

tee; P. R. Ferguson, auditor of the Southern Sierras Power Co., chairman of the accounting committee; R. E. Fisher, assistant manager of the commercial department of the Pacific Gas & Electric Co., chairman of the commercial section; L. M. Klauber, assistant general manager and superintendent of the San Diego Consolidated Gas & Electric Co., chairman of the engineering committee, and Robert Sibley, editor of the *Journal of Electricity*, chairman of the publicity committee.

GENERAL ELECTRIC CO. SHIPMENTS MOUNT TO HIGH LEVEL.

Showing for First Five Months of 1920 Are at the Rate of $255,000,000 for the Current Year's Business.

In the first five months of 1920 the billings of the General Electric Co., Schenectady, N. Y., were at an annual rate in excess of anything in the company's previous history. Shipments for the five months' period totaled $106,252,420, or at the rate of $255,000,000 for 12 months. Prior to this year, 1919 was the record fiscal year, with shipments of about $230,000,000. It is of interest to note that no longer ago than in 1916 the company was transacting only $134,000,000 of gross business, which indicates a rate of expansion approaching 100% in four years.

The company's detailed statement for the five months ended May 31, last, reveals profits available for dividends of $15,286,687, this figure being without provision for federal taxes. In other words, if the remaining seven months of 1920 produce the same proportionate balance of profits the total for the year would be $36,688,000, compared with $36,077,970 in 1919.

Last year the company set aside $11,000,000 for taxes. As the federal income and excess profits tax rates are the same this year as last it is probable that the company has set aside the same figure for the tax deduction. This would leave $25,688,000 available for dividends, equal to a little over $20 a share on the $125,400,000 stock which will be outstanding at the end of the present year. The General Electric Co. in 1919 earned 20.8% on the total capital stock outstanding Dec. 31, 1919, so that the profit indications for the current year do not deviate materially from the actual performance in 1919.

PROFESSORS OF ENGINEERING TAKE SUMMER COURSE.

Westinghouse Electric & Manufacturing Co. Class Has Representatives from 14 Colleges and Universities.

Engineering professors from 14 colleges and universities and from 13 states are in attendance at the summer course for engineering teachers held by the educational department of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

This course is designed to give engineering professors the advantages of practical experience in manufacturing. Lectures are given by heads of the various departments of the company and the professors are able to combine theoretical and practical knowledge to their advantage.

The professors taking the course and their colleges are as follows: S. W. Anderson, Virginia Military Institute; William Anderson, Rhode Island State College; G. C. Blalock, Purdue University; B. B. Brackett, South Dakota State College; R. E. Brown, University of Pennsylvania; P. H. Burkhart, University of Illinois; J. M. Cochran, State University of New Mexico; P. H. Daggett, University of North Carolina; M. M. Flanders, Bliss Electrical School; V. B. Hall, Bucknell University; W. B. Hall, Sheffield Scientific School; J. H. Mustard, University of North Carolina; W. L. Teague, University of Arkansas, and F. G. Tucker, State College of Washington.

Engineering Professors Who Are Taking Westinghouse Summer Course.

EARLY ADOPTION OF WATER-POWER RULES PLANNED.

Government Commission to Start Work on Drafting Regulations Under Federal Act Within Next Few Weeks.

Although the federal water-power commission will not hold its first meeting until the return of Secretary of the Interior John Barton Payne from Alaska early in August, tentative regulations for the administration of the federal act opening up the country's vast water-power resources are now being drafted. As soon as they are completed the commission, which consists of the secretaries of the War, Interior and Agricultural Departments, will hold hearings on them. The hearings on the regulations will be pushed as speedily as possible so that the water-power legislation can be put into effect with as little delay as possible.

The tentative regulations are being drawn up by a special committee of the War, Interior and Agricultural Departments. It is composed of Maj. Gen. Enoch H. Crowder, representing the War Department; O. C. Merrill, water-power expert in the forestry service, who has been designated executive secretary of the commission, and H. A. Stabler of the Interior Department.

Members of the committee say the regulations will be extensive and that they probably will be announced in series, with open hearings on each group before they are made final. Those relat-

ing to form and condition of application for survey permit or licenses will be the first announced.

The most difficult problem involved in drawing up the regulations, members of the committee say, is that of establishing a uniform system of accounting for licenses as required by the act.

Under the water-power bill the commission is empowered to issue licenses for a period not exceeding 50 years. The licensees will pay to the government reasonable annual charges in an amount to be fixed by the commission. Upon the expiration of any license the government, if two years' notice in writing has been given by the commission, will have the right to take over and operate any water-power development after payment of the net investment of the licensee in the project or projects taken, not to exceed the fair value of the property plus such reasonable damages, if any, to property of the licensee as may be caused by the severance therefrom of property taken. In cases where such notice has not been given the government will have the right to take over upon mutual agreement with the licensee any property developed under the terms of the bill subject to the payment of the net investment made in the development.

REPORT AMERICANS HAVE STOCK IN GERMAN COMPANY.

According to an article published in the *Frankfurter Zeitung* a large block of stock in Siemens & Halske, one of the largest German electrical manufacturing concerns, has been obtained by American interests in payment for copper and nickel shipped to the concern. Although the amount of the transaction has not been made known, it is reported that an American corporation, headed by Gen. George W. Goethals, has offered $35,000,000 for the stock.

EDISON SHOWS HE CAN STILL USE TELEGRAPH KEY.

Veteran Inventor Sends Message to Old Time Telegraphers' Historical Association and Demonstrates He Still Knows Code.

For the first time in 19 years Thomas A. Edison used a telegraph instrument to send a message, when, on July 20, from his laboratory in West Orange, N. J., Mr. Edison ticked off a message to a committee representing the Old Time Telegraphers' Historical Association, David Homer Bates, secretary of the United States Military Telegraph Corps, receiving the message in the Western Union Telegraph Co. headquarters in New York City.

The message sent by Mr. Edison was addressed to the "Telegraph Fraternity," and read as follows: "Amid the activities of a busy life full of expectations, hopes and fears, my thoughts of early association with my comrades of the dots and dashes have ever been a delight and pleasure to me. I consider it a great pleasure to record in Morse characters on an indestructible disk this tribute to my beginnings in electricity through the telegraph and with it a Godspeed to the fraternity throughout the world."

The message was recorded on a disk that will be kept for historical purposes by the association. Mr. Edison's speed with the key is not what it used to be, Mr. Bates said, but he demonstrated that he had not forgotten the alphabet and that he used to be a rapid operator. The last message sent by Mr. Edison was in 1901, when he sent a message to Chauncey M. Depew at the opening of the New York electrical exposition.

CENTRAL NEW YORK STATE COMPANIES COMPLETE MERGER.

The consolidation of the former Mohawk-Edison Co. and the Adirondack Electric Power Corp. was completed last week in conformity with the orders of the New York State Public Service Commission, Second District, authorizing the merger. The merged properties will be known as the Adirondack Power & Light Corp. and do business in the territory extending from the Vermont and Massachusetts line through the upper Hudson Valley and extending up the Mohawk Valley to Canastota and Oneida to the west of Utica. The aggregate gross business for the last twelve months is in excess of $4,000,000.

JAPANESE GOVERNMENT PLANS TO ELECTRIFY RAILROADS.

Recent advices from Tokyo, Japan, state that a bill has been introduced by the government in the Japanese Parliament creating the Imperial Electric Railway Co., the aim of the bill being to establish an electric power supply for railroads and to gradually convert all steam railroads to electricity for motive purposes. The capital stock will be 100,000,000 yen ($50,000,000), of which one-half will be invested by the Japanese government and its dividend will not exceed 10%. In the event that sufficient profit is not made to warrant the paying of 6%, no dividends will be paid on the stock paid by the government but will be applied for dividend on the privately owned stock.

COMING CONVENTIONS.

Michigan Section of the National Electric Light Association. Annual convention, Ottawa Beach, Mich., Aug. 24-26. Headquarters, Hotel Ottawa. Secretary, Herbert Silvester, Ann Arbor, Mich.

Nebraska Section of the National Electric Light Association. Annual convention, Omaha, Neb., Sept. 8-9. Secretary, B. H. Conlee, Nebraska Gas & Electric Co., Beatrice, Neb.

Pennsylvania Electric Association. Annual convention, Bedford Springs, Pa., Sept. 8-11. Secretary, H. M. Stine, 211 Locust street, Harrisburg, Pa.

New England Section of the National Electric Light Association. Annual convention, Kineo, Me., Sept. 13-16. Secretary, O. A. Bursiel, 149 Tremont street, Boston, Mass.

Illuminating Engineering Society. Annual convention, Cleveland, Sept. 27-30. General Secretary, Clarence L. Law, 29 West 39th street, New York City.

National Association of Electrical Contractors and Dealers. Annual convention, Baltimore, Md., Oct. 4-8. Headquarters, Southern Hotel. Secretary, W. H. Morton, 110 West 40th street, New York City.

International Association of Municipal Electricians. Annual convention, New Orleans, La., Oct. 19-22. Secretary, Clarence R. George, Houston, Tex.

COMMERCIAL PRACTICE

New-Business Methods, Policies, Rates and Kindred Central-Station Matters for the Man Engaged in Selling Electricity

DISCUSSES RISING COSTS AND THE UTILITY COMMISSIONS.

Missouri Public Service Commissioner Says Returns on Utility Investments Must Be Made Attractive and Certain.

That modern utilities are the outgrowth of every necessity, and their development has inevitably followed the natural demands of our complex civilization, was a statement made by David E. Blair, a member of the Missouri Public Service Commission, at a recent meeting of the St. Louis Electrical Board of Trade.

The commission plan of regulating utilities represents the modern and better attitude toward utilities and their relations with the public, declared Mr. Blair, and, continuing, he expressed the opinion that regulation supersedes competition and that public service is paramount to but not regardless of earnings of the utilities. Reasonable compensation must go hand in hand with adequacy of service. The cost of rendering that service must be provided for in the rates, regardless of franchise limitations, as the state cannot suffer its police power to be abridged or limited by a franchise entered into between a municipality and its utility. Bare cost of operation does not furnish or guarantee ability to render service and no utility can long remain in a position to render adequate service unless it can show earnings to those who own its stocks and bonds.

According to Mr. Blair it is no wonder that the utilities looked with suspicion upon the growing demand for state regulation or that it was thought that the utilities had nothing to gain and everything to lose by state regulation, while the public apparently had everything to gain and nothing to lose. Had it not been for the era of high prices caused by the world war these respective attitudes might have remained unchanged.

The increasing costs of operation rendered the utilities incapable of furnishing adequate service at franchise rates, and they suddenly found their only salvation from bankruptcy or costly injunction proceedings in the courts lay in the very boards whose creation they had so bitterly opposed. The public, to its utter surprise, learned that such boards not only had the power to fix rates lower than those named in the franchise, but also the power, and sometimes the duty, to authorize rates in excess thereof. Positions were exactly reversed in short order. The opponents of state regulation became its champions; its former champions became its critics.

It has been no pleasant task to concur in rulings which have resulted in increasing street-car fares, gas rates and charges for electricity, water and telephone service beyond the rates named in supposedly airtight franchises. It is true that while men smilingly and complaisantly pay two or three times the old prices for food and clothing, building materials and for their amusements, an advance from 20 to 40% in utility service rates is always met by a storm of popular disapproval. Somehow the general public does not get the idea that if labor, fuel and materials have advanced from 75% to 300% their utilities will have difficulty in rendering service at the same old price or have any honest claim for an increase in the price of their product. That is a most short-sighted attitude. But that is the attitude of at least the unthinking part of the public and these constitute the chief critics of the commission.

One thing is sure and that is that unless the returns on utility investments are made more attractive and certain, it will become more and more difficult to enlist new capital in such business and the public will ultimately be the chief sufferer. Those people who already have their money invested in such enterprises cannot be expected indefinitely to put in more and more money to protect that already invested.

CENTRAL-STATION ENERGY OUTPUT IN 1919 WAS LARGE.

1919 Figures Show Central-Station Companies Generated 39,559,000,000 Kw-Hrs. of Energy and Employed Over 100,000 Men.

Few outside the business realize the magnitude to which the electrical central-station industry has grown, and the firm foundation upon which it now rests, as well as the future ahead of it. At this time there is scarcely a central-station company which is able to supply the demands made upon it for power for industrial uses. A serious handicap has been the difficulty in obtaining new generating equipment, manufacturing companies being over burdened with orders.

The figures for 1919 are staggering. The 7243 central-station companies in the United States generated 39,559,000,000 kw-hrs. of energy and employed over 100,000 men. This current was carried over more than 87,000 mi. of high-tension transmission lines, serving, in addition to the many industrial plants, more than 8,000,000 homes with light and supplying light and power to more than 1,000,000 business establishments. Over 5,000,000 electric motors were in use at the end of the year.

As to the future, it is estimated that there yet remain in the United States 14,000,000 houses to be wired for electric light, 150,000 industrial establishments to be equipped with electric power and a possible electric furnace load of tremendous proportions. With a steady increase in population and industrial growth, the future field of the industry seems to be limited only by the

conditions established governing its ability to attract investors to furnish new capital so as to make the extensions necessary to meet the increasing demands for service.

RULE ON ABANDONMENT OF SERVICE MADE IN ARKANSAS.

State Commission Says Company Furnishing Light Has No Right to Cease Service When Rate Increase Is Refused.

The Arkansas Corporation Commission recently issued a ruling denying that a company supplying light and power to a city had the right to discontinue such service when a request for an increase in rates was not granted. The decision arose out of a petition filed by N. G. Sawyer, a citizen of Leslie, Ark., to compel the Mays Manufacturing Co. to continue to furnish him with a supply of electricity.

At hearings on the petition it was brought out that April 1, 1913, the city of Leslie granted to the Mays Manufacturing Co. the exclusive right for a period of 50 years to furnish electric service in the city. In consideration of the franchise so granted, Ed Mays, doing business as the Mays Manufacturing Co., agreed on his part that during the life of the franchise he would provide and maintain a sufficient supply of electricity to supply the demands of the city for heating, lighting and power purposes at the prices and upon the terms mentioned in the franchise.

Operation under the franchise was continued up to May 14, 1920, at which time the Arkansas Corporation Commission denied a petition of Mays for an increase in rates. Mays filed no motion for a rehearing nor did he take an appeal from the decision, but on May 20, 1920, notified his customers that he declined to furnish electricity to the inhabitants of Leslie any longer.

On receiving this notice Mr. Sawyer appealed to the commission asking that Mays be restrained from discontinuing or attempting to discontinue service to his customers until such time as the commission could have a final hearing on the petition. The commission granted a temporary restraining order, directing Mays to continue service, but at the final hearing June 2, 1920, it was shown that Mays had disregarded the orders of the commission and had refused to furnish service.

In making its ruling the commission pointed out that there was no question that though the Mays Manufacturing Co. consisted of but a single individual, there was no doubt but what it came under the regulatory powers of the commission. Numerous cases in Arkansas and other states were cited to prove this contention. In ordering Mays to restore service the commission said in part:

"The Arkansas Corporation Commission, acting for the state, could, on proper showing, grant any public service company the right to cease operation and to dismantle its plant, but the defendant has made no such application here. His action denies the power of the state to regulate his business and defies the officers of the state to take any steps for the protection of the public. He holds, on the one hand, a franchise issued to him by a municipality, which is a part of the state government, which franchise gives to him the exclusive right to maintain an electric light plant in the city of Leslie, which franchise he has not surrendered, and on the other hand, he refuses to comply with its terms, as was so aptly said in the Kansas case, supra, 'To yield approval to the contention of the defendant is to concede that the state's program for the regulation and control of public service corporations is ineffecttve; that the public utilities act has been enacted in vain.'

"It is true that the defendant had heretofore filed his application for an increase of rates, but he was not entitled to this increase as a matter of right merely upon his application, but the burden was upon him to establish by a preponderance of the evidence that such increased rates were necessary. The commission held in that case that the defendant had not presented evidence sufficient to justify the increase. The case was dismissed without prejudice to any future rights which the defendant might have, and he was given an opportunity, if he saw fit, to present his evidence in such a manner that the commission would be able to ascertain what the true condition of affairs was. He had his remedy; he could have reinstated his suit, shown by proper audit of his books that he was not getting an adequate return on his investment, or he could have stood on his original proceeding and filed a motion for rehearing within twenty days (which he did not do), and if the rehearing was denied he could have appealed to the Supreme Court. None of these things he saw fit to do. He elected, on the other hand, to treat the contract with the city of Leslie as a scrap of paper, to defy the authorized representatives of the state government and to trample under foot the rights of those whom he was serving in the town of Leslie.

"This commission will issue an order directing that the defendant continue to furnish adequate and reasonable service to the citizens of Leslie, and that he re-establish connections wherever broken and that he again resume his duties in the operation of public service company."

OUTLOOK IS GOOD FOR INVESTORS IN UTILITIES.

In an article entitled "Utilities Resisted Best the Shock of Adverse Conditions" an Eastern financial paper states that when public utility industries can stand up under circumstances such as have been experienced recently and still continue to pay investors interest and dividends and maintain properties in good condition it gives authority to the statement that these businesses are inherently stable. In the long run the confidence of the investor is amply justified. With each graduation approaching normal conditions the welfare of well-managed electric public utilities is bound to be enhanced. The day is almost sure to come when investments of this class will be looked upon with unanimous favor, and the holders of the better known electric utility securities will be envied by many who have placed their money in various other kinds of enterprises within the past few years.

OPERATING PRACTICE

Methods and Problems Embracing Operation and Installation of Power-Plant Equipment and the Distribution of Electrical Energy

SELECTION OF LUBRICATING OILS AND THEIR USE.

Notes Taken from the Report of the Committee on Prime Movers of the National Electric Light Association.

Oil should be selected with regard to the individual conditions of the service in which it is to be used. Viscosity should be referred to the actual temperature of operation rather than to the conventional standard of 100 deg. F., if the best use is to be made of the viscosity values in passing upon different oils. Viscosity at the actual temperature of service is essential because of the fact that different oils do not have the same viscosity variations with equal variations in temperature. The specific gravity of oil, its emulsifying tendency when mixed with water or its frothing when churned with air and, to a certain extent, its flash point are factors to be considered in judging the merit of a given oil.

Oil in service should be tested at intervals because of the fact that its physical properties are subject to considerable variation with age and use. Manufacturers make oils which will operate satisfactorily at 160 deg. F., but it is recommended that temperatures above 140 deg. F. be avoided if possible. Temperatures reported as existing in actual practice in the bearings of large turbines and generators vary from 98 to 167 deg. F., and oil leaving the cooler and in the oil tank varies in temperature from 88 to 140 deg. F.

Purification of dirty oil or oil mixed with water may be accomplished by filtration or in a mechanical separator. Such treatment of the lubricating oil greatly increases its effectiveness, saves the bearings and at the same time reduces the oil bill.

33,000-VOLT EXTENSION LINE FOR CLAY COMPANY.

Taps Important Transmission Line of Public Service Co. of Northern Illinois to Supply Power Service.

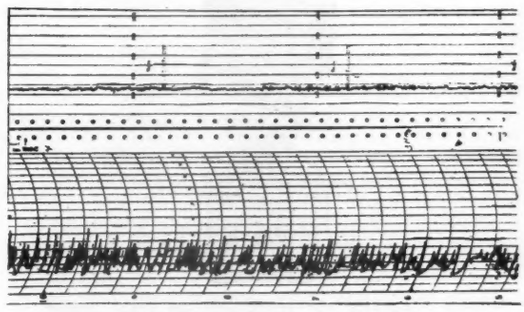
An interesting transmission line is in operation at Streator, Ill., its function being to supply electric service to the Barr Clay Co., manufacturer of building and paving brick. The line is a 33,000-volt extension, about one-quarter of a mile long, which taps the transmission line of the Public Service Co. of Northern Illinois, between Pontiac and Streator, Ill., through a pole-mounted switch and fuse. The extension is on wooden poles and the line is of No. 6 wire and terminates in the customer's substation, which is of modern type.

The substation equipment consists of three 150-kv-a., 33,000-volt transformers on a concrete base with choke coils, disconnects, high-tension fuse holders and insulators mounted on a steel supporting structure. The concrete base is also occupied by a type "O. F." 33,000-volt lightning arrester. The low-tension leads from the transformer are run underground to inside the customer's building where they terminate in an oil switch at a distribution switchboard. The substation layout provides for three 333-kv-a. transformers should future demands for energy be beyond the capacity of the present bank of transformers.

AUTOMATIC CONTROL SAVES ENERGY INPUT TO FURNACE.

Increased Production and Longer Electrode Life Among Benefits Attained by Use of Regulating Equipment.

Practically all electric furnace rates are based upon total energy consumed, expressed in kilowatt-hours and the maximum demand as derived from the connected load over a definite period of time. This means that the lowest power rate occurs when the full connected load exists all the time; the load-factor is then 100%.



Load Curves of the Same Furnace with Hand and with Automatically Controlled Electrodes.

In practice, the electric furnace is far from a steady load. There are violent peaks and current rushes when starting up from cold, because when the electrodes are brought together a virtual short-circuit occurs one minute and the current is interrupted altogether at the next minute. Furnace loads are unsteady and the fluctuations occur over a wide range, affecting the power rate and interfering with voltage regulation and furnace performance.

By using automatic furnace regulators for controlling the electrodes or energy supplied to the furnace, the cost of one man can be saved and a much more steady input obtained. This means lower labor cost, increased furnace tonnage, faster production, less wear and tear generally

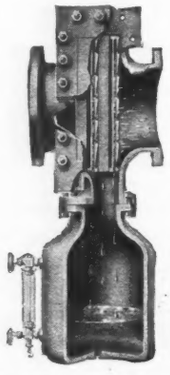
on equipment, longer electrode life, and more closely predeterminable results.

Furnace operation follows the cycle of heating cold metal, melting metal, increasing temperature of the molten metal, and pouring. So many kilowatt-hours are needed for each operation and these vary but slightly for a definite condition. The first heat starting with a cold furnace requires the largest number of kilowatt-hours, the second heat requires less and the third and fourth still less. Furnace operators equipped with a recording ammeter or wattmeter are able to judge very closely from their records the condition of a heat. The furnace that is equipped with instruments will turn out more metal for the same power consumption than the one not so equipped.

SEPARATOR FOR REMOVING OIL FROM EXHAUST STEAM.

Efficiency Necessitates Steam Being Free From Oil Before Steam Is Returned to the Boiler or Used in Heating Coils.

It is generally known that separators are used in almost all modern power plants for the removal of oil from the exhaust steam. Steam, in its passage through pumps, engines and other lubricated steam-using devices, picks up a certain amount of oil. This oil, unless separated



Bundy Separator for Removing Oil from Steam.

in some manner, passes on with the exhaust into heating coils, condensers or feed-water heaters unless the spent steam is wasted in the open air. Since exhaust steam is never wasted in a modern plant, provision must be made for its utilization.

If the entrained oil is allowed to remain in the exhaust vapor, its effectiveness is greatly reduced and under some circumstances the oil may produce a serious hazard. When oil is allowed to enter a set of heating coils or radiators it collects on the inside surfaces and fouls them until their efficiency is greatly reduced. It also collects in the drain lines, shutting them off or fouling the drain traps. In case the steam is used in an inclosed feed-water heater the result is much the same and a large portion of the available heat is lost in addition to the fouling of the heater. In either case the condensate is not fit for return to the feed-water system, and still further losses have to be borne because of the failure to properly clean the exhaust steam. When an open feed-water heater is used the entrained oil goes directly into the boiler feed system. Oil in the boiler feed system results in the formation of a coating in the boiler shell, accompanied by a reduced efficiency of heat transmission and a corresponding increase in the amount of coal required. If the oil coating is allowed to remain and increase it may result in the permanent injury or actual destruction of the boiler or of the entire plant in case of an explosion.

The accompanying illustration shows clearly the construction of a standard type of separator with shell and baffle plates made of cast iron. These multiple baffle plates are of special staggered grid construction and are so designed as to insure the removal of all oil from the exhaust steam before it leaves the separator. Oil, after being deposited on the saw-tooth grids, enters a duct inside of the grid bars and flows through this duct to the larger receiver reservoir at the bottom. This construction prevents other steam from picking up the oil again after it has been deposited on the baffle plate.

It is apparent if an oil separator is efficient that the separation cannot be accomplished without the baffle-plate surfaces becoming gummed with oil and grease and also that this coating reduces the separating efficiency. It is, therefore, essential that an oil separator be so constructed as to be easily cleaned. The baffle plates in this separator are removable through an opening provided and may be taken out and cleaned in a lye solution and returned to the separator ready for another period of service.

ELECTRIC FURNACE LOAD AND THE CENTRAL STATION.

Large Furnace Loads Now Carried on Central-Station Systems and Larger Loads Are Expected in the Future.

The furnace load now carried by the Duquesne Light Co., Pittsburg, totals almost 4,500,000 kw-hrs. per month, according to an article by John M. Nairn appearing in a recent issue of the Duquesne Light Co. *News*. The demand produced during April of this year by the connected furnace load amounted to 17,603 kw., and, it is stated, the furnace business produces approximately 5% of the total monthly revenue. An examination of actual conditions developed the fact that the furnaces in the aggregate produce a load-factor of 31.1%. A number of contracts have been closed for new furnace services, and it is predicted that the present connected load will be doubled within a year. A survey of the existing conditions in Pittsburg showed an available load of only about 8500 kw. in the non-ferrous metal melting field, but estimates of the available load in the steel industry reach figures of many times this value. One estimate predicts a total furnace load of 300,000 kw. for the Pittsburg steel district.

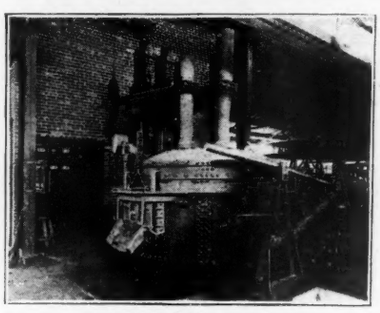
There are a total of 15 arc-type furnaces now connected to the company's lines, some of them having capacities of as high as 15 tons and requiring an input of 3000 kw. at full-load operation. These furnaces operate at about 100 volts and require at times a current of 20,000 amperes or more.

FURNACE DEVELOPMENTS

Descriptions and Illustrations of the Design and Application of Representative Types of Electric Furnace Equipment

Moore 'Lectromelt Furnace for Iron and Steel Work.

Iron and steel melting and refining furnaces manufactured by the Pittsburgh Electric Furnace Corp., Pittsburgh, are of the Moore type. Attention paid to the minute details of design and construction has resulted in the incorporation of



Small 'Lectromelt Steel Furnace.

many desirable features in the furnaces made by this manufacturer.

Transformers of special design and construction, with multiplex connections for various power conditions, allow for melting down the charge at the most rapid rate and refining with the proper voltage and current. Because of the special design of both transformers and furnace the power input required is quite low. Furnaces of 3-ton capacity may be operated on approximately 550 kw-hrs. per ton, while the larger furnaces may reduce this figure to 520 kw-hrs. per ton. The melting-down period in standard furnaces is 1 hr., this time being made as short as possible when due consideration is given to the many other factors involved.

The furnace is supported slightly above its center of gravity, and is so mounted that even the largest size may be tilted by hand. A large hand wheel shown in the accompanying illustration serves to tilt the furnace. Motor-driven tilting gears are provided on the larger equipments, all gears and equipment being located at the side of the furnace and out of danger from a spilled heat. Electrode supports are actuated, through a set of cables, by motors installed inside the transformer vault. This type of construction protects the motors from excessive heat and possible physical damage. Automatic regulating equipment supplemented by hand controls, govern the furnace input in accordance with the requirements of the process.

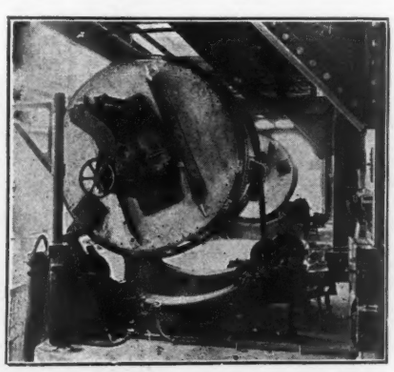
Among the advantages claimed by the manufacturer of this equipment are ruggedness, simplicity, convenience, and speed of operation. Furnaces are made in eight different standard sizes and may be made to suit the special demands of a great variety of production requirements. One user of this make of furnace reports a total of 254 heats in a single month from a 3-ton furnace. The total material melted in the furnace during this month amounted to 786 tons, or over 3 tons per heat. The Electric Steel Co., Chicago, reports a production of 12 heats per day, with a daily output of about 42 tons for four consecutive days during July. The furnace in this case was supplied with power through a 1000-Kv-a, transformer; the transformer regulation and heating in many cases is a limiting factor in furnace output.

Brass-Melting Electric Furnace for Direct Pouring.

The accompanying illustrations show the new direct-pouring type of electric furnace made by the Detroit Electric Furnace Co., Detroit. This company states that there are now over 50 furnaces of its manufacture in daily use, and that this number will be increased to a total of 79 on completion of the equipment now ordered.

Of this number 63 furnaces are of the 1-ton size, ten are of the 0.5-ton size and six are of the 0.25-ton size. The furnaces are designed to melt their rated capacity of brass per hour and can be overloaded approximately 25% when charging the ordinary foundry charges consisting of ingot, foundry scrap, borings, etc. Capacities of the transformers supplied with these furnaces are 300, 150 and 75 kv-a., respectively. They are special electric-furnace transformers supplied with variable voltage and impedence taps connected on the job as required by line conditions. Power-factors obtained on Detroit furnaces vary from 82 to 92%.

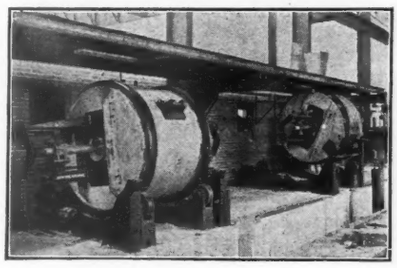
Installations are working in foundries, rolling mills and smelting and refining plants, and all grades of brass and bronze alloys as well as



View of Detroit Electric Furnace.

copper and aluminum are being successfully handled. Most of the Detroit furnaces installed in the rolling mills are melting yellow brass of 60% copper and 40% zinc or alloys of that approximate analysis. One Detroit rolling-mill furnace, however, is working on phono-electrical metal composed approximately of 98% copper and 2% tin, while several furnaces are melting pure copper. One such installation is melting copper scrap, the metal being poured into wire bars.

A total of 14 furnaces are working in the city of Detroit on bronzes for automobile bearings, and smelting



Typical Installation of Two Detroit Furnaces.

and refining plants are using furnaces for making composition ingot of various analysis. It may be stated here that the alloys to be melted can be changed on each successive heat from one grade of brass alloy to another without contaminating the mixes. One smelting plant has changed the mix going into a single furnace five times in a day without unsatisfactory complications.

High melting efficiency and low melting shrinkage are claimed for this type of furnace. It is stated that the shrinkage amounts to only 0.5% on red brass and to 1% on yellow alloys, and that the power consumption totals from 210 to 225 kw-hrs. per ton of yellow brass and to 275 kw-hrs. per ton for red brass. Ample data is available to illustrate the probable costs of operation for the melting of any type of alloy.

Greaves-Etchells Furnace with Resistive Hearth.

The method by which heat is introduced into the steel bath of the electric furnace is of great importance. In most types of electric furnace heat is generated by means of electric arcs formed between the electrodes themselves or between the electrodes and the metal bath. The disadvantage of this type of furnace is that the heat is applied at the top of the charge only, the tendency under such conditions being for the top of the charge to become superheated while the bottom may be comparatively cold. Construction and design features employed in the Greaves-Etchells system are intended to overcome this and some of the other electric furnace problems. One of the important features is the hearth lining which is never less than 20 ins. thick, and is constructed mainly of dolomite and magnesite. Its electrical resistance

is high at the inside of the bath in proximity to the charge and decreases rapidly to a negligible quantity at the outside.

The Electric Furnace Construction Co., Philadelphia, have the American rights to this furnace, which was originally produced in England, and manufacture them in this country.

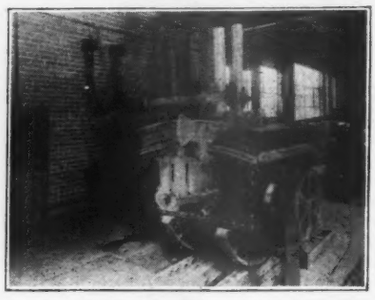
Two phases of a three-phase low-voltage supply are connected to their respective upper graphite or carbon electrodes, while the third phase is connected to the bottom of the hearth. This system of connection, at first sight, would appear to cause an unbalanced load on the primary supply, but the system of transformer ratios is arranged to give a perfect balance when the upper electrodes are in equal adjustment. The current flowing through the hearth generates a considerable amount of heat immediately below the liquid, while the electric arcs arranged over the bath maintain the slag and surface at the desired temperature. The effect of this bottom heating is to cause convection currents in the molten metal, thus insuring a constant circulation and a uniform product. The outside of the furnace bottom remains cold, little or no heat being lost in this direction. With the Greaves-Etchells furnace stirring is entirely eliminated, and practical tests, such as the effect of the molten steel on a cold rod, show temperature uniformity to a remarkable degree.

The high-voltage power supply is transformed by means of a delta-star system of connection to low voltage, the transformer house being as near as possible to the furnace in order to avoid heavy copper costs and energy losses in the low-voltage connections. Equipment is designed to withstand short-circuiting of the phases, as this occurs in all furnaces during the melting process when pieces of metal fall against the electrodes. A method often adopted by furnace builders to provide against this is the introduction of considerable reactance in the electrical system, but, since this reduces the energy available in the furnace it increases the energy losses, and may be otherwise objectionable.

The Greaves-Etchells system of transformer connections is such that the short-circuit current of one electrode must traverse two transformers in

Greaves-Etchells Furnace, Showing Control Panel and Tilting Gear.

series and in different phase, which automatically lowers the power-factor momentarily and has a strong buffer effect; the fact that there is always a permanent resistance in the path of the current through the hearth also limits the effects of short-circuits. Combination of these factors provides an effective means for protecting the supply system from shock, while allowing a very high power-factor to be obtained on normal load. Energy supplied to the furnace is regulated over a considerable range by raising or lowering the electrodes, and this can be done



Greaves-Etchells Furnace Being Emptied After a Heat.

by hand or by means of automatic regulators which maintain the current at a predetermined value. Arrangements are also provided for varying the voltages across the arcs, in all except the smallest size of furnace, giving a high voltage during the melting period and a low voltage during refining. In addition the ratio of heat generated above and below the bath can be regulated over a wide range.

Other special features include limit switches on the electrode arms and tilting mechanism, and a special non-clogging rocker arrangement which always maintains the center of gravity just below the center of radius of the rockers themselves. These features provide substantial protection against the neglect of careless or unskilled operation. Electrode economizers of a special design, described on page 961 of ELECTRICAL REVIEW of June 5, 1920, are provided as a portion of the equipment on these furnaces. Linings as made are especially rugged, some users of the furnaces stating that from two to three years' service may be had from a single lining. In one case the operator claims to have melted 2341 heats of high-speed steel on the original furnace lining.

Gronwall-Dixon Melting and Refining Furnaces.

Operating data taken on a 5-ton Gronwall-Dixon furnace, manufactured by John A. Crowley, Detroit, shows a record of over 800 heats with the equipment still working and turning out a large volume of product. The operation of the original furnace is continuous. A cold charge, consisting of various kinds and grades of scrap together with a percentage of pig iron, is placed in the furnace and from this material heats of nickel, chrome-nickel, chrome-vanadium, high-silicon and high-manganese, high-carbon and high-speed steels may be made within a period of 4 to 5 hrs., with an energy consumption of from 500 to 600 kw.hrs. per ton. Under favorable conditions many heats of steel refined to under 0.02% sulphur and phosphorus have been completed in a little over 3 hrs. with a minimum energy consumption of 460 kw-hrs. per ton. In making these grades of steel practically 90% are to carbon specifications requiring considerable recarbonizing of the bath as well as the addition of the necessary alloys. The specifications are in all cases exacting, and the charge must be held in the furnace while a sample is analyzed for carbon, manganese, nickel, chromium and vanadium, according to the grade of steel made.

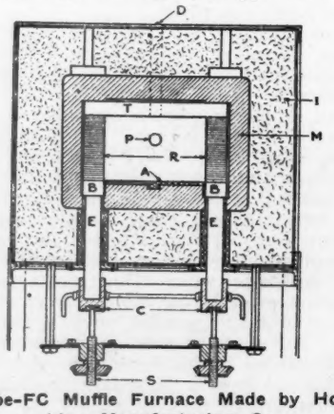
The Gronwall-Dixon furnace operates on a two-phase system, energy being taken from three-phase supply through two banks of transformers connected by a modified Scott three-phase to two-phase connection. In units of 5 tons and larger capacities, four vertical electrodes are introduced through the roof. The bottom electrode is embedded under the lining of the hearth and is entirely protected from the molten charge. It therefore requires no water cooling. In capacities smaller than 5 tons, two electrodes are introduced through the roof.

The cost per ton of liquid steel, reduced to under 0.025% sulphur and phosphorus, produced in a 5-ton furnace amounts to $27.50 plus the cost of 550 kw-hrs. of energy. These costs are divided as follows: 30 lbs. of electrode, $2.25; refractories, $0.80; alloys, $1.50; scrap and iron, $20; skiled labor, $1.50, and unskilled labor, $0.75. Costs for material for steel castings are somewhat less, the amount totaling $23.85 plus the cost of 500 kw-hrs. of energy.

Hoskins Type FC Muffle Furnace for Heat Treatment.

The details of proper heat-treatment are well recognized, yet the results that are produced by that treatment depend entirely upon the extent of the control which the operator holds over the process. This applies not only to the temperature of the furnace, but also to the atmospheric condition within the heating chamber. At the temperatures required for the heat-treatment of high speed steel, control over these two factors is especially difficult if a fuel-fired furnace is used. This is true because the equipment has to be forced to such an extent that fine regulation of either the temperature or the furnace atmosphere is practically impossible.

In the type FC furnace, made by the Hoskins Manufacturing Co., Detroit, the operator has almost perfect control over these two very important factors which limit the quality of tools more than any other. Herein lies the value of the electric tool furnace. The type FC fur-



Type-FC Muffle Furnace Made by Hoskins Manufacturing Co.

nace is of the carbon-plate resistance type, a diagramatic section of the equipment being shown in the accompanying illustration.

The heating elements *R* are located on each side of the heating chamber and consist of a series of rather narrow carbon plates, each plate being about

0.25 in. thick. These two rows are connected at the back end of the furnace by a set of heavier carbon plates *T*. The carbon plates *R* rest on another heavy graphic block *B*, which evenly distributes the pressure delivered through the graphite electrodes *E*.

Type FC furnaces are insulated with infusorial earth in powdered form. It is packed between the muffle and a heavy boiler-plate casing, very effectively retarding the heat radiation and resulting in economical power consumption.

Furnaces are made in a number of sizes and shapes to accommodate various classes of work. A furnace 6.5 ins. by 5 ins. by 12 ins. has a full load rating of 15 kw., and a furnace 12 ins. by 8 ins. by 18 ins. has a full load rating of 30 kw. A full equipment consists of a furnace, switchboard and transformer. The switchboard is provided with a pyrometer, ammeter, circuit-breaker and a line switch.

Knowing the current required, the operator can set the furnace by regulating the hand screws, *S*, and secure any desired temperature up to 2500 deg. F. The furnace will produce higher temperatures, but the linings are not capable of withstanding the higher temperatures for a long period of time. In addition to this particular furnace, this company produces a great variety of similar equipment and many types and styles of pyrometers, meters and other instruments.

Baily Resistance-Type Brass-Melting Furnace.

Furnaces of the resistance type, and known as Baily electric furnaces, are made by the Electric Furnace Co., Alliance, O. The heating element consists of a circular trough of carborundum packed with granulated carbon, and is installed on brick piers supporting it around the body of the furnace and above the melting hearth. When the power circuit is closed the heating element becomes incandescent and gives off heat at high temperature to the linings and materials on the hearth. By the circular form of the heating element and the shape of the furnace lining a uniform heat is projected by radiation and reflection onto the materials to be melted.

Resistor material must be renewed about once in two weeks, and the carborundum trough is good for about six to eight months of service. However, special arrangements provide for the ready renewal of the carbon, and the trough can be renewed by replacement with a new part. Transformers and other auxiliary equipment with the Baily furnace are designed and built to serve the particular needs of the service required. A special switch makes provision for the selection and ready connection of the proper power input for a given charge and melting rate.

Records of furnace performance in the plant of the Standard Sanitary Co., Louisville, Ky., show shrinkage losses of from 0.361% to 1.6% for the melting of yellow brass scrap. A slightly better record is shown for work done in the plant of the Capitol Brass Co., Detroit, on the same material, and in phosphor-bronze melting in the plant of the Buick Motor Co., Flint, Mich., a loss of only 0.24% was recorded.

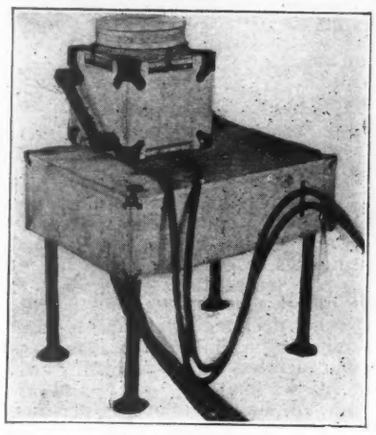
Installation of Five Baily Furnaces.

Ajax-Northrup High-Frequency Induction Furnace.

The high-frequency induction furnace makes possible the heating of a cylinder, sphere or other solid shape of conducting material without the use of an arc or other electrical connection to the mass to be heated. The mass may be surrounded completely with refractory material so that the heat losses are reduced to a minimum. Refractory materials around the mass are in turn surrounded with a single layer solenoid carrying an electric current of high frequency. The coil remains cold while the mass of material attains a high temperature due to eddy currents induced in it. Unlike other induction furnaces, there is no necessity for an interlinkage of a magnetic circuit with the electric circuit. With furnaces of proper proportions temperatures have been attained sufficient to melt molybdenum, whose melting point is said to be 2550 deg. C.

Furnaces of this character, and the required auxiliary equipment, are manufactured and marketed by the Ajax Electrothermic Corp., Trenton, N. J. Special equipment is manufactured and supplied to transform and utilize the standard voltages and either single, two or three-phase service. Frequencies of 50,60, and 550 cycles have been transformed to meet the requirements of this type of equipment, which is made for capacities up to 60 kw.

The high-frequency converter system has no moving parts and is highly dependable. It will operate day in and day out without trouble according to the statement of the manufacturers. The only attention necessary is an occasional inspection of the mercury discharge gap. About once in 500 hrs. of full-power operation two small graphite tips must be unscrewed from their position and replaced with new ones. This and other similar costs are small and of but minor importance.



High-Frequency Induction Furnace of Ajax Northrup Type.

A typical form of single-phase furnace is shown in the accompanying illustrations. When two or three phases are used on the same furnace the inductor coil is separated along its length into two or three equal sections and the voltage from one phase is impressed upon each section. The coil is made of copper tubing and is cooled with water which flows through it. When polyphase currents are employed independent water terminals are supplied for each phase. The material to be heated absorbs practically all the heat generated, there being no electrodes to carry away heat as in the ordinary electrode steel furnace, and no terminals to carry away heat as in the ordinary resistance furnace. The furnace can be made closely to approach the spherical form, so that minimum radiating surface is exposed to the refractory lining.

A good idea of the various details of operation and construction is secured by a careful examination of the illustrations. The diagram shows the various basic details, and the photograph shows how these details are worked out in a practical working unit. If a nonconducting material is to be melted, a conducting crucible is used, while nonconducting crucibles are used when conductive materials are to be melted.

For melting in vacuum a long quartz tube is used, the bottom of the tube being closed with the bottom and side walls molded in one piece. The top is sealed by luting on an aluminum ring and sealing above this a water-cooled plate into which the vacuum pipe is inserted. As there are no electrical connections to run through the walls of the vacuum

chamber, a high vacuum is readily maintained. The pump for producing the vacuum may be of any type available and suitable to the service.

A special gold and silver-melting furnace having a capacity of 209 lbs.

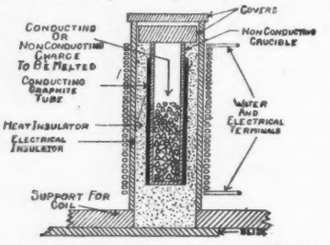


Diagram Showing the Various Parts of an Induction Furnace.

has been developed and is in use. This furnace requires an input of 18 kw., and melts approximately 180 troy ounces of gold per kw-hr. of input. A temperature sufficient to melt nickel may be attained in this particular design. Platinum melting is carried on in lime, zirconia or magnesia crucibles, thus producing the heat in the material itself, and assuring an uncontaminated product. Glass may be melted using a nickel container where the temperature is not over 1425 deg. C., and a quartz tube for temperature up to the softening point of the quartz.

The maximum temperature to be reached, in melting or heat-treating a mass of material, has a very great bearing on the total amount of material which can be heated at one time with a given amount of power. The aim, of course, in melting is to make as large as possible the figure representing lbs. per kw-hr. over a considerable period of time. Crucibles for holding the charge should be made smaller for high melting metals than for low melting metals. This is illustrated by the fact that a 2.25-in. by 7-in. chamber lined with graphite will attain a temperature of 2500 deg. C. in a period of 15 min., while a similar chamber having 7.25 in. inside diameter and a length of 36 ins. will attain a temperature of only 925 deg. C. in an hour, when both are supplied with an input of 12 kw.

Operating Data and Costs of Furnace Operation.

Operating data from a steel foundry producing small castings in an acid-bottom furnace of the American type of Rennerfelt furnace, handled by Hamilton & Hansell, Inc., New York City, and operating in the daytime only, shows a total daily input to the furnace of 7325 lbs. of material. This type of furnace has three electrodes, and is suitable for operation from either two or three-phase circuits. One electrode enters the furnace through the roof and the other two enter from opposite sides.

This material was handled in 14 hrs 11 min., and the furnace used 2330 kw-hrs. of energy for the four melts. It is interesting to note that the power efficiency of the furnace increased from 2.38 lbs. of material melted per kw-hr. in the first heat to 3.68 lbs. per kw-hr. in the fourth or last heat. These figures show the importance of continuous operation as a feature in power economy.

Other figures quoted from the operation of a 3-ton furnace working on a 7-heat, 24-hr.-day basis indicated the total cost per ton of melted steel to be $23.55, exclusive of the power cost. These charges were divided as follows: Labor, $2.00; maintenance and repairs, $0.80; refractories, $0.70; water, tools and incidentals, $0.22; 1.5 lbs. of aluminum, $0.51; 6 lbs. of 50% ferrosilicon, $0.24; 10 lbs. of 80% ferromanganese, $0.50; 10 lbs. of graphite electrode, $2.20; 1200 lbs. of scrap, $10.80; 800 lbs. of machine turnings, $4.80, and 5% melting loss, $0.78. The total power consumption amounts to 650 kw-hrs. per ton, and depends for its cost upon the rates prevailing in the locality.

Melting of cupro-nickel, composed of 75% nickel and 25% copper, requires 500 kw-hr. per ton and involves an approximate loss of 0.32%. The melting time in 1000-lb. heats is 1 hr. 30 min. Bronze containing 95% of copper requires 1 hr. 5 min., and the use of 300 kw-hrs. per ton in 1000-lb. heats. The loss for bronze is approximately the same as for cupro-nickel. The melting of silver dollars requires only 200 kw-hrs. per ton, and the 1000-lb. heats take only 50 min. In this case the melting loss is only about 0.05%. Aluminum requires 350 kw-hrs. and monel metal requires 700 kw-hrs. per ton for melting in a 1-ton furnace. The melting loss for aluminum is approximately 1.1% and that for monel metal 0.3%.

Vom Baur Electric Furnaces.

Since many electric furnaces now in use in the iron and steel industry start with a cold charge, it is important to have the charge melt down as quickly and cheaply as possible. The furnaces designed and built by C. H. Vom Baur, New York City, are intended to accomplish this melting down in as short a period of time as is consistent with the many factors involved. This is accomplished by having the middle electrode carry a higher current than the remaining two, the furnace being connected two phase by the three-wire system during the melting-down period.

The second or refining period follows the melting-down period, and it is almost wholly during this period that the refractories are worn away, due to the radiated and reflected heat and the chemical action of the bath and slag. As the wearing away due to the latter cause is practically the same for all furnaces doing the same class of work, particularly attention should be given to this point. One of the most serious limitations of any electric furnace of this kind is in the refractories, and it is manifestly best to place them so that they receive equal heat. It is not practical to distribute the heat equally over the entire roof, but it is comparatively an easy matter to do this for the large stretch of the entire banks, sidewalls and outer edge of the roof by having the electrodes in one line and making the shape of such an oval that the heat impinging on the entire interior periphery of these banks, sidewalls and roof is equal.

This shape is chosen to go with an equal distribution of heat, and requires a change of electrical connections from two to three phase. The change is made by means of a switch which provides connection for making a three-wire, three-phase, open-delta circuit of the transformer secondaries. This electrical change, in addition to providing suitable alterations in the heat distribution during the two periods of operation, also reduces the power input by 14% without other changes in the connection. However, for refining, the power input can be further reduced by reducing the voltage used.

The manufacturer states that this furnace can be relined quickly, works rapidly on the refining processes, is simple and has the correct shape to properly distribute the heat generated. Furnaces of this type are made in capacities of from 0.5 to 30 tons per heat.

Electric Steel Furnace With Conducting Hearth.

Arc-resistance electric furnaces built by the Booth Electric Furnace Co., Chicago, are usually of the two-phase type, but may be built for either single or three-phase operation if required. An auxiliary electrode, which acts as a common return for the two main electrodes of a two-phase furnace, is used in starting the melting operation. In basic operation an especially designed conducting hearth is used to carry the entire power input after becoming heated to the steel-melting temperature.

This hearth is divided into two equal parts, and is separated through the center by a strip of solid material serving to electrically insulate each of the two sections from the other. Either cast-steel grids or copper bus bars, imbedded in the base of each of these sections, are used as conductors. The auxiliary electrode is employed for an average of 20 min.

Booth Electric Steel-Melting Furnace.

per heat, or until the bottom becomes conducting, after which time it is drawn up away from the bath and serves only to plug the hole through which it enters the furnace.

In the two-phase furnace the phases entering through the two main electrodes are connected through to the two separate portions of the hearth, so that the electric current passes through the bath and out through the contra-wise section of the hearth, causing a positive mixing action and aiding in the refining of the steel. There is also a definite heating effect on the hearth itself occasioned by the passing of the current through it, preventing the formation of skulls and aiding in the circulation of the metal. As many as six de-sulphurizing slags may be made and pulled in 3 hrs. time, thus reducing the sulphur content from 2.5% to under .009%. This special bottom construction is built up in the furnace layer upon layer, each sintered in by the use of the

electric arc. The result is a solid one-piece bottom, requiring very little repairs and being practically permanent.

For acid operation the special conducting hearth is not required, but the auxiliary electrode is used throughout the entire heat. The accompanying illustration shows many of the features of this furnace. Furnaces are made in five standard sizes from 0.75 to 15 tons in capacity, and are designed to melt and pour from 12 to 15 heats of simple steel per day of 24 hrs. Oval-shaped furnaces are favored by this manufacturer, especially in the larger sizes and where the basic process is to be used. Doors of suitable size are provided at the front over the pouring spout, at the rear for charging and slagging, and in the 6 to 10-ton furnaces another door is located along the side for slagging and other manipulation. Tilting mechanisms are all located at the floor level, and at the side of the furnace, there being no equipment in the pit. Electrode holders are made of castings and are counterweighted, no structural steel being used, and special design permits of the shifting of carbons in the holder without climbing onto the hot furnace roof. The manufacturer states that electrode consumption amounts to 18 to 20 lbs. per ton of steel, and that the power requirement averages not to exceed 600 kw-hrs. per ton in the smaller furnaces. In basic operation the roof is expected to serve for from 150 to 200 heats before relining is required. Liberal capacity rating, safe construction, and reliable control provisions are other features of this equipment.

Electrically Operated Spring-Tempering Furnaces.

Few automobile users realize to what an extent the heat treatment of the springs influences both safety and comfort while riding and also the life of the car. Heat treatment applies equally to heavy motor trucks and pleasure cars, and for essentially the same reasons. With poorly heat-treated springs, necessitating a low rate of action, the engine and body of the car are subjected to a continuous succession of shocks which cause cumulative mechanical strains that cannot do otherwise than render it a more or less permanent visitor to the repair shop.

Possibly the reason why this question of spring reliability has not been more prominent is because the manufacturers of the springs have taken such care in heat treating that failures of springs are the exception. This principle of giving the greatest care to the processes used in properly tempering springs, and the most up to date methods of heat treating and drawing, is exemplified in the plant of the Spring Perch Co., Bridgeport, Conn., maker of various types of high-grade automobile and vehicle springs.

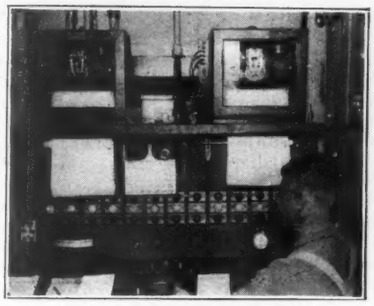
One of the processes used by that company presents an interesting example of the application of electric heat to this form of industry. When the springs have been hardened they are exceedingly brittle, and it is necessary to give them a heat treatment called tempering to reduce this brittleness and still retain temper. In doing this it is highly important that all springs receive the same amount of heat penetration in order that the product be uniform.

For this purpose the company has installed two electrically heated furnaces, which are round in form and about 12 ft. in diameter, the hearth consisting of a revolving steel table about 10 ft. 8 ins. in diameter. These tables are driven by an electric motor, and the speed can be varied from one revolution per hour to one in 20 minutes, according to the class of work to be done. The springs are put on this table through a door in the side and taken out of the same door when finished. With this arrangement the production is about 2000 lbs per hr. for each furnace, or in a 16-hr. day the two furnaces turn out about 64,000 lbs.

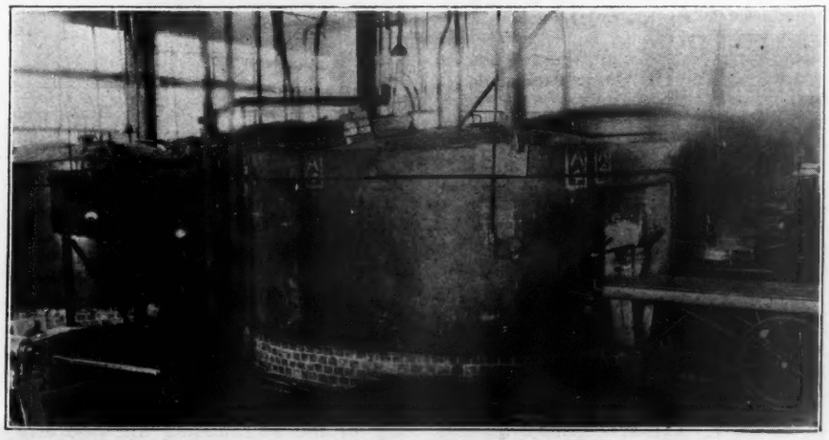
The heating units which were made by the General Electric Co., Schenectady, N. Y., are installed in the roof of the furnace, about 10 ins. above the table. The roofs of the furnaces are arched to reflect and give an even distribution of heat throughout the interior of the furnace. All hot spots which would cause some springs to be heated more than others, or otherwise destroy the uniformity of the product, are eliminated by this method of construction.

The control, which is entirely automatic, was also supplied by the General Electric Co. and consists of a temperature-regulated contactor panel for each furnace. All that is necessary to obtain any temperature desired between 800 and 1000 deg. F. is to set the regulator and close the switch for that furnace. Owing to the automatic control the furnace will run itself and keep absolutely to the exact degree of heat required. Since it is desirable to vary the degree of heat, in accordance with the varying composition of the springs to be heated, the value of an absolutely reliable and flexible temperature control is self evident.

These features of accurate temperature control, and evenness of heat distribution for any temperature, are the factors which insure uniformity of the finished product and are in the main confined to electric furnace practice. The Spring Perch Co. subject all its product to a Brinell test to determine its perfection before shipping, and claim to be securing an absolutely uniform product.



Furnace Control Panel for Spring Tempering.



Two Spring-Tempering Furnaces in Plant of Spring Perch Co.

Treatment of Metal Parts in Highly Heated Air.

The process of relieving the strains in metal parts arising from the sudden contraction attending the tempering process has long been carried on by means of an oil bath, and the temperatures used as well as the time required for the treatment have been determined as a result of individual experience. There is divided opinion as to what actually takes place during this stress relieving operation. However, it is agreed that the degree of heat determines the condition of the resulting product, and later opinion seems to favor the belief that the degree of heat is not the only factor, but that another factor, time, is equally important. According to this latter explanation the extent of the return to stable equilibrium of the molecular structure is proportional to the product of a function of the heat applied and the time of treatment. For example, with a certain steel-product, tempering strains might be fully relieved by bringing the product to a temperature of 350 deg. F. and soaking at that temperature for an hour, whereas the same results might be obtained by employing a temperature of 375 deg. F. for 45 min.

On this theory it will be noted that in order to produce uniform results the quantity of heat supplied, that is the product of time and temperature, should be constant. If the operation be plotted using temperatures of the material as ordinates and time as abscissas it will be noted that the area beneath the curve, or the time integral of the heating curve, must be the same in order to give the same results.

The older method consisting as mentioned above of immersing the product in an oil bath, the temperature of which is left to the control of an operator as is also the length

of the treatment, depends on the human element to secure the best results.

It is well known that the chemical composition of the steel, the tempering heats used, the speed of cooling and other factors which arise under special conditions, all have their effects on the precise cycle of subsequent "drawing" best suited to give the desired results. Any apparatus which will tend to place the two variables of temperature and time under the easy control of the operator will have accomplished much in the way of simplifying this process and of standardizing methods. Methods of controlling the temperature of oil baths are slow acting, and rarely result in producing a uniform temperature distribution within the product itself. It is also necessary to remove the oil from the product before passing to the next operation, this in itself being an expense item of no small importance. All of these factors taken into consideration have led to the design by the Young Brothers Co., Detroit, of a heat treating equipment which combines the advantages of several modern devices. The heat conveying medium has been changed from oil to air, even heat application has been obtained by blowing preheated air in great volume through and over the product, the temperature is maintained constant with the aid of modern thermostatic apparatus and flexibility of heat control is obtained through the use of electricity as a heating agent.

Cost of operation from a fuel standpoint is kept low by employing the highest grade of oven construction of the insulated steel type the wall losses of which do not exceed 40 B. t. u. per sq. ft. at 350 deg. F. The conveyor principle has been applied to reduce handling costs. A regenerative heating scheme is also employed so that the outgoing work gives up its useful heat to the incoming, thus greatly reducing the total heat required.

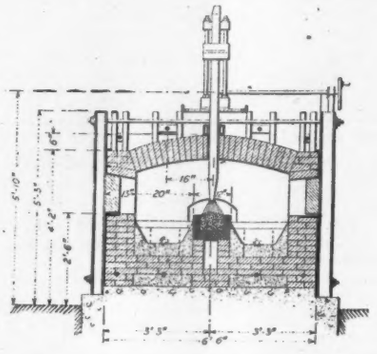
This apparatus can be especially designed to meet the requirements of any manufacturers who have considerable volume of production, and where the product treated does not vary widely in individual size and weight. It should be particularly attractive to manufacturers of ball bearings and similar products.

Rennerfelt Type of Electric Reverberatory Furnace.

On Jan. 1, 1920, there were a total of 148 Rennerfelt electric reverberatory furnaces in service in 16 different countries and 12 different types of service. This furnace, which is built and marketed by Hamilton & Hansek, Inc., New York City, generates heat by means of an arc or arcs drawn between electrodes and a conducting bed located horizontally within the furnace. The generated heat strikes the melting chamber both directly and indirectly by reflection from the curved roof.

A wide range of temperatures can be obtained by shortening or lengthening the arcs formed between the electrodes and the conducting bed, and it is also possible to obtain a smothered arc by bringing the electrodes in direct contact with this conductor. In the latter case the same conditions will prevail as in ordinary fuel-fired reverberatories. These arrangements tend to give the furnace a wide range of applications in various processes, such as the smelting of ores, reduction of chemicals, distillation processes, bullion smelting and melting, refining of copper, etc., and also in the melting of all non-ferrous metals and alloys.

The furnace is rectangular in shape and is built of common firebrick retained



End View of a Rennerfelt Reverberatory Electric Furnace.

within a reinforced steel box for the smaller sizes and held together with buckstays, skew-backs, etc., for large capacities. The smaller sizes can be made tiltable, whereas the large furnaces will always be stationary. The roof is also of common firebrick and can be built stationary or removable as occasion may require. Electrodes enter through the roof vertically and the number of electrodes depends principally on the characteristics of the current, but to some extent also on the size of the furnace.

The electrical equipment necessary for the furnace is quite simple for the reason that only a single potential of 100 volts is required, since all heat regulation is obtained by fixing the distance between the conducting bed and the electrodes. No external resistance is necessary. In general, therefore, the electrical equipment consists of an oil switch, transformer, instruments and the necessary cables or busbars to bring the current to the electrode contacts. The electrode regulation can be either manual or automatic.

As all the electrodes are in one row, any multiple can be added to give additional length with the accompanying increase in capacity. Hearth widths may be made suitable to the size or capacity required. When multiple electrodes are employed they can be connected to the same transformer by splitting the phases, but it may be of advantage to employ a number of transformers, each controlling one set of electrodes independent of the other. By this arrangement it is possible to regulate the heat in the various sections of the furnace.

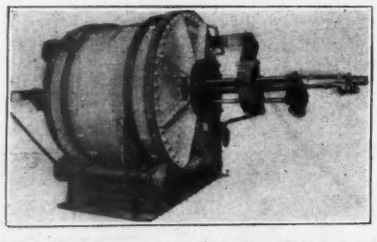
The melting chambers are located on both sides and somewhat below the top of the conducting bed. These chambers are lined with either acid or basic materials, as need may require, and the bottoms slope slightly toward the tap holes, located in the front of the furnace. It may be noted that these melting hearths are independent of each other, making it possible to charge and tap either one without disturbing the process going on in the other. This arrangement tends to cheapen the labor cost and also to increase the daily output of the furnace. Glass and enamel may be melted in this type of furnace by making slight changes in the construction and substituting tanks for the melting chambers.

Rotating Electric Furnace for Brass Melting.

Heat supplied directly from the arc, by radiation from the walls and by absorption from contact with the lining during rotation are features typical of the rotating brass furnaces manufactured by the Booth Electric Furnace Co., Chicago. The special construction employed uses one or two doors, located at the axis of the rotating drum or cylinder, through which the two electrodes enter the furnace. The power is carried by the tracks on which the furnace rotates, and from these by a flexible copper connection direct to the clamps holding the electrodes. This track is insulated from the shell, and so designed as to have ample carrying capacity for all currents used. Complete rotation of the furnace during the melting operation produces a mixing action, and increases the life of the lining.

Furnaces are built in four sizes rated at from 250 lbs. to 1 ton, and are designed to melt and pour heats at the rate of one every 40 min. or 1 hr., depending upon the material melted. Both hand and automatic electrode controls are provided, and special transformers are supplied where high-voltage a-c. service is to be used. Furnace ends are of one piece construction, and can be removed when it is necessary to renew the linings. The furnace may be removed from the rolls and placed on end for the relining process, thus allowing for the installation of a particularly suitable lining. Only about 24 hrs. time is required for the entire relining process. Three push-buttons control the rotating motor which is mounted directly on the furnace base, and serves to move the furnace in either direction as desired.

Special features claimed for this furnace include the ability to melt volatile alloys including brass and



Rotating Furnace for Melting Brass and Other Non-Ferrous Materials.

other non-ferrous materials with a small volatilization or shrinkage. Movement of the metal prevents local heating, and oxidation is prevented because of the close fit of the doors which close the openings in the furnace ends. Linings are said to last from four to six months, and the carbon consumption may be kept down to 1½ lbs. per ton of melted metal by careful operation. Heat insulation is provided to prevent the undue heating of the surrounding air, and also to keep the power consumption down to a minimum.

ACTIVITIES IN THE TRADE

Business Developments, Sales Agencies, Trade Literature and Miscellaneous Items Concerning Electrical Manufacturers and Allied Business Interests

B. & M. Electric Co., 472 Main St., East Orange, N. J., has filed notice of organization to operate a local electrical works. Frank Maloney, 120 South 15th St., East Orange, heads the company.

Home Utilities Co., 115 North Desplaines street, Chicago, has issued folders describing the "Klymax" electric vacuum washer, in which full details of the manufacture and operation of the machine are given.

Cutler-Hammer Manufacturing Co., Milwaukee, has issued a reprint of an article on "Extension to L. Street Station, Boston," in which the operation of the Dean control for gate valves is described and illustrated.

Eimer & Amend, Third avenue and 18th street, New York City, have issued a number of bulletins dealing with pyrometers, metallographic equipment and other appliances handled by the firm, including the Kimley electro-analysis apparatus for the rapid determination of copper, tin, zinc, lead, etc.

Benjamin Electric Manufacturing Co., Chicago, is sending the trade in pamphlet form reprints of a recent article in *Printers Ink,* written by G. A. Nicholls, which the Benjamin company calls "Pioneering in Correct Farm Lighting." In the article the rural dweller is shown the publicity advantages of a well-illuminated farm.

Combustion Engineering Corp., 475 Tenth avenue, New York City, announces the appointment of Henry Kreisinger, formerly of the United States Bureau of Mines, as research engineer. Mr. Kreisinger will conduct investigations similiar to those that he conducted for the government bureau in his new position and will make his headquarters at the Bureau of Mines station in Pittsburgh.

Mermaid Electric Dish Washer Co., Middletown, Conn., announces that H. W. Karstens has been appointed sales manager of the company. Previous to joining the Mermaid organization Mr. Karstens was sales manager of the electrical jobbing house of Elliott-Lewis Co., Philadelphia. His earlier experience in the electrical trade was gained with the Franklin Electric Manufacturing Co., and the Holophane Works of General Electric Co.

Rochester Electric Products Co., Rochester, N. Y., has been formed to manufacture the "Rochester" electric motor, the men interested also being connected with the Rochester Motor Corp., which in the future will concentrate its attention on the Duesenberg type of automobile engine. The officers of the new company are: Edward F. Davidson, president and treasurer; Joseph H. Kimmel, vice-president, and E. Darwin Smith, Jr., secretary.

Crouse-Hinds Co., Syracuse, N. Y., is sending the trade bulletin No. 100N in which is described and illustrated the "Mogul Obround" series of condulets manufactured by the company.

National X-Ray Reflector Co., Chicago, in continuing its practice of supplying architects with working information on lighting material, is sending out a new series of detail plates showing recent installations made by the company.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is making a feature of a display in flowers of its trade mark at its South Philadelphia works, where a mound shaped flower bed 60 ft. in diameter has been made. The mound, as shown

Trade Mark of Westinghouse Electric & Manufacturing Co., In Flowers.

in the accompanying illustration, is circular in form and is set on an 18-in. incline. The outer circle is 30 ins. wide and is formed by 2000 coleus plants, which bears foliage of a bright crimson color. The bars of the capital "W" are 4 ft. wide and are formed by 2000 coleus plants of a canary yellow color. Under the "W" the words "Westinghouse Electric & Manufacturing Co.," is shown in a bar 33 ft. long and 2.5 ft. wide.

Holt Electric Co., Jacksonville, Fla., has appointed Charles H. Avery general manager of sales and purchases. Mr. Avery was formerly in the sales department of the New York City office of the V. V. Fittings Co., and has figured prominently in the selling field of the electrical industry for the past 16 years.

Remmert Manufacturing Co., Soulard and DeKalb streets, St. Louis, is sending the trade a descriptive circular telling the merits claimed by the company for its "Airplane" electric washing machine. The company has contracted for its entire output for the next 18 months and the work of remodelling its factory is nearly completed. The officers of the company are William Remmert, president; E. H. Wagner, vice-president; Alfred Bannantine, treasurer, and K. Husbands, secretary.

Alphaduct Co., 136 Cator avenue, Jersey City, manufacturer of electrical conduit, has filed plans for the erection of a one-story addition to its plant on New street.

Electric Contracting Co., Trenton, N. J., formerly known as the Adams Electric Co., is planning for improvements in the building on property at 11 North Stockton street, recently acquired by the company for expansion purposes.

Hobart Brothers Co., Troy, O., has issued bulletin No. 64 describing the 10-battery charging outfit recently placed on the market by the company. The bulletin carries illustrations of the battery charger, which is full 600-watt equipment and can automatically handle 6, 12 or 24-volt batteries at the same time.

Pelton Water Wheel Co., 19th and Harrison streets, San Francisco, is sending to the trade an album of plant installations made by the company portraying in interesting form the scope and activities of the company in the hydroelectric field. The illustrations show Pelton units operating under widely varying conditions of head, volume and capacity, and embrace horizontal and vertical turbines of both reaction and impulse type used in generating stations, automatic and remote control plants and for exciter sets.

Appleton Electric Co., Chicago, manufacturer of conduit fittings, is building a new plant which will double its present capacity. The main building will be L-shaped, four stories and basement, and will provide 45,000 sq. ft. of room. In addition the company will build a power house covering 140,000 sq. ft. of space. The new plant will be located at Paulina and Wellington streets and will have railroad facilities. The officers of the company are: A. I. Appleton, president and treasurer; F. H. Merrill, vice-president, and J. V. Painter, secretary. The company maintains branch offices in New York City and San Francisco.

Roller-Smith Co., 233 Broadway, New York City announces the following changes in its sales organization: C. L. Crosby, previously sales manager, is now general sales manager at New York City; M. Frankel, previously assistant sales manager, is now western sales manager at Chicago; W. J. Shire, previously sales engineer, is now eastern sales manager at New York City; C. G. Kahant, previously sales engineer, is now export manager and district sales manager at New York City. F. R. Ryan, J. E. Wood and H. D. Baker remain district sales managers, respectively, of the Chicago, Cleveland and Detroit territories. In addition to the above C. M. Hunt is sales engineer at the New York City office and M. B. Mathley holds a similar position at the Chicago office.

PERSONAL MENTION

Biographical Sketches and Chronicle of Changes in Business Connections, Promotions and Other Personal News of the Industry

W. N. DICKINSON, consulting engineer, was elected president of the New York City Electrical Society at the recent annual meeting of the organization.

G. W. BERNHARD has been appointed manager of the northwestern division of the Great Western Power Co. of California, with headquarters at Napa, Cal.

OWEN D. YOUNG, vice-president of the General Electric Co., Schenectady, N. Y., has been elected a member of the board of directors of the General Motors Corp.

COL. E. M. STAYTON has been appointed a member of the board of control of the Kansas City Railway Co. Colonel Stayton will represent the city on the board.

HARRY W. GODDARD, president and treasurer of the Spencer Wire Co., Worcester, Mass., will spend three months inspecting mining property near Mt. McKinley, Alaska.

G. R. KENNY, formerly rate research engineer with the San Joaquin Light & Power Corp., Fresno, Cal., has resigned to accept a position with Stone & Webster, Inc., Boston.

E. W. MORELAND, formerly with the Portland (Ore.) Railway Light & Power Co., as efficiency engineer, is now engaged in appraisal work at Montreal, Que., for the Canadian government.

CHARLES ORRIN FOSS, of the St. Johns & Quebec Railway, St. Johns, N. B., has been appointed a member of the newly-formed Hydro-Electric Power Commission of New Brunswick.

SIDNEY G. JOHNSON is now president of the Signal Service & Supply Corp., New York City. He was formerly vice-president of the General Railway Signal Co., Rochester, N. Y.

CHARLES JEWETT PARSONS has been added to the sales staff of the Celite Products Co., New York City. Mr. Parsons is a graduate of Massachusetts Institute of Technology and specializes in power-plant work.

A. PEARSON HOOVER, formerly a lieutenant-colonel in the construction department of the United States Army, has been elected vice-president of the Holbrook, Cabot & Rollins, Corp., general contractors, Boston.

HARRIS J. RYAN, of the electrical engineering department of Leland Stanford, Jr., University, Stanford, Cal., has been elected a member of the National Academy of Sciences in recognition of his work in connection with high-tension insulators.

R. F. SCHUCHARDT, electrical engineer of the Commonwealth Edison Co., Chicago, sailed for Europe on July 24 and will make a tour of England and France for the purposes of inspecting the latest developments of the electrical industry in these countries. Mr. Schuchardt was accompanied by W. S. Monroe, of Sargent & Lundy, consulting engineers, Chicago.

S. B. CONDIT, JR., has been elected president and treasurer, and F. D. Masterson vice-president and general manager of The Chase Shawmut Co., Newburyport, Mass.

S. H. TAYLOR, general manager of the Electric Railway & Manufacturers' Supply Co., San Francisco, has been appointed secretary of the Pacific Coast Section of the National Electric Light Association by President L. H. Newbert.

D. J. HARD, who was elected president of the Ohio Electric Light Association at the recent convention held at Cedar Point, O., has been prominent in the electrical industry in Ohio for many years, his father, Col. C. V. Hard, having been one of the pioneers in the electric light business in Ohio. Mr. Hard is treasurer of the Cleveland Light & Power Co., and is vice-president of the Wooster (O.) Electric Co., the latter company having been founded by his father. Mr. Hard's home is in Cleveland.

D. J. Hard.

R. B. TYLER, general manager of the Gulf States Telephone Co., Tyler, Tex., is now president of the Texas Independent Telephone Association, having succeeded E. C. Blomeyer, who resigned on leaving the state to engage in business in Chicago.

L. D. CANFIELD, assistant district service manager at the New York City office of the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has been appointed district service manager, succeeding L. G. Richards, who has been transfered to East Pittsburgh. In the Los Angeles, Cal., office of the company G. O. Noble has been appointed special representative, G. B. Kirker manager of the railway division and R. A. Hopkins manager of the power and marine division.

EDWARD W. HARRY, electrical engineer, left the electrical department of the National Tube Co., McKeesport, Pa., July 17, to accept a position as chief electrical engineer of the Pittsburgh Steel Co., Monessen, Pa.

PHILLIP B. KENNEDY, formerly chief of the Bureau of Foreign and Domestic Commerce, Washington, D. C., is now vice-president of the First Federal Foreign Banking Association, 40 Wall street, New York City.

C. F. NEEDHAM, electrical and mechanical engineer of the Grand Trunk Railway of Canada, has been appointed assistant to the general superintendent of motive power and car department, with offices at Montreal, Que.

WILLIAM F. STROUSE, acting chief engineer for the Maryland Public Service Commission, Annapolis, Md., for the past six months, has been appointed chief engineer of the commission, to succeed the late Charles G. Edwards.

E. C. BLOMEYER has resigned the presidency of the Texas Telephone Co., Waco, Tex., and is now connected with the Automatic Electric Co., Chicago. Mr. Blomeyer was also president of the Texas Independent Telephone Association, until he gave up the position on leaving the state.

WILLIAM M. ROSBOROUGH has been transferred from the Nela Park headquarters of the National Lamp Works of General Electric Co. to the Pacific Coast office of the company at San Francisco, where he will take up the duties of assistant to J. A. Vandergrift, Pacific Coast manager.

LLOYD HENLEY, assistant electrical engineer of the California Railroad Commission, has been appointed valuation engineer for the San Joaquin Light & Power Corp. and has also been appointed chairman of the committee on rules for overhead line construction in the state of California.

OBITUARY.

WILLIAM R. DRIVER, Beverly, Mass., treasurer of the American Telephone & Telegraph Co. from 1880 until his retirement, died at his Beverly residence, July 20, aged 82 years. His son, William R. Driver, Jr., is general manager of the New England Telephone & Telegraph Co.

JAMES MITCHELL, president and one of the organizers of the Alabama Power Co., died recently at his home in New York City, aged 54 years. Mr. Mitchell was one of the founders of the Brazilian Traction, Light & Power Co and installed the first trolley cars in South America. He was also president of the Alabama Interstate Power Co., Alabama Traction, Light & Power Co., Ltd., Little River Power Co., and was a director in the Cities Service Co., Mexican Northern Co., Muscle Shoals Hydroelectric Power Co., and Utah Securities Co.

BUSINESS OPPORTUNITIES

News of Electrical Construction Projects in All Parts of the Country, Proposals Invited, Foreign Trade Openings and New Companies

EASTERN STATES.

Fall River, Mass.—The Sanford Spinning Co. has filed plans for the erection of an electric transformer Station at its works.

Holyoke, Mass.—A power plant for general operation will be constructed by the New England Tire & Rubber Co. in connection with its three-story tire manufacturing plant, 100 by 200 ft.

Holyoke, Mass.—The Holyoke Water Power Co. is considering the erection of a building at Dwight and Railroad streets, to cost about $150,000.

Taunton, Mass.—The municipal lighting commission plans to construct a one-story addition to the city electric light plant.

Wakefield, Mass.—The Heywood Brothers & Wakefield Co. is considering plans for the erection of a one-story power house at its local furniture factory.

Norwich, Conn.—The United States Finishing Co. is completing plans for the erection of a power plant at its textile mills, to replace the structure recently destroyed by fire, estimated to cost about $400,000, with equipment. Day & Zimmerman, Inc., 611 Chestnut street, Philadelphia, Pa., is the engineer on the project.

Buffalo, N. Y.—The Chicago Telephone Supply Co., a Maine corporation, capitalized at $500,000, has filed authorization to operate in New York, with H. Taylor, Buffalo, as state representative.

Buffalo, N. Y.—Plans are being prepared by Architect Julius C. Schultz, 1370 Main street, for the erection of a power house, one-story, 40 by 50 ft., to cost about $10,000.

Monticello, N. Y.—Fire July 17 destroyed the two-story building occupied by the exchange plant of the New York Telephone Co.

New York, N. Y.—The United State Rubber Company, Broadway and 58th street, has arranged for a note issue of $20,000,000. The proceeds will be used in part for the completion of extensions to plants at Detroit, Hartford, Providence and Indianapolis, now under way, including electrical and other machinery installation.

New York, N. Y.—The Exide Battery Depots, Inc., 101 West End avenue, has acquired property at Spring and Clark streets, 115 by 125 ft., to be used for the erection of a service works to cost about $225,000.

New York, N. Y.—The New York Telephone Co., 15 Dey street, is completing plans for improvements and extensions in its five-story exchange plant at 112 West 89th street, to cost about $50,000. About August 1 the company, through Architects McKenzie, Voorhees and Gmelin, 1123 Broadway, will take bids for the erection of a three-story exchange at Rockaway, L. I., 30 by 30 ft.

New York, N. Y.—Considerable electrical and mechanical equipment for handling and storing materials will be installed by the Interborough Rapid Transit Co. at its storage yards at Brooklyn, estimated to cost about $390,000.

New York, N. Y.—The New York Edison Co. has broken ground for the construction of a one-story power house on Grand avenue, Brooklyn, to cost about $40,000.

Olean, N. Y.—The Olean Electric Light & Power Co. is having plans prepared for the erection of an electric power plant, steam-operated, to cost about $100,000. Day & Zimmerman, Inc., 611 Chestnut street, Philadelphia, is the engineer on the project.

Potsdam, N. Y.—The St. Lawrence Transmission Co., 39 Market street, has made application to the State Public Service Commission for permission to build an addition to its power plant at Hammond, N. Y., and for the approval of a franchise for local operation.

Rossie, N. Y.—George Juengst & Sons have made application to the State Public Service Commission for permission to make improvements and extensions in their local power plant.

Schenectady, N. Y.—The Adirondack Power & Light Corp. has filed notice of increase in capital from $5,000,000 to $13,800,000. The proceeds will be used in part for the erection of a hydroelectric power plant on the Mohawk river, near Albany, N. Y.

Elizabeth, N. J.—The Simmons Co. has let contracts for the construction of a new power plant, estimated to cost $600,000.

Edgewater, N. J.—The engine and boiler plant, and other works departments of the Midland Linseed Products Co., were partially destroyed by fire, July 16, with loss estimated at $250,000.

Jersey City, N. J.—Electrical and mechanical equipment will be installed by the Continental Candy Co. at its ice plant on Claremont avenue, to cost about $18,000, exclusive of equipment.

Lakehurst, N. J.—In connection with the enlargement of its local aircraft works, the Navy Department, Washington, D. C., will build a new auxiliary electric power plant, machine and repair shops, and a number of other structures. The work is estimated to cost about $3,577,000. The new buildings are expected to be ready for service in the spring of 1921.

Newark, N. J.—The New York Telephone Co. has filed plans for the erection of a one-story shop.

Ocean City, N. J.—The city commissioners are negotiating with the Atlantic City Electric Light Co. for improved lighting service and facilities along the Boardwalk.

Trenton, N. J.—The Trenton Traction Co., organized as a holding company, and which has been inactive for many years, has filed notice of dissolution. John A. Rigg, Philadelphia, is the president of the company.

Trenton, N. J.—The city commission will call for new bids at an early date for electrically operated pumping machinery, hydraulic equipment and other apparatus for the municipal waterworks pumping plant. Former bids were not considered owing to protests of "closed" specifications.

Trenton, N. J.—The State House Commission is arranging for the early appointment of engineers to make an appraisal of the physical property of the Public Service Railway Co.

Trenton, N. J.—The city is planning on installing 25,000,000 gal. pump and 1000-hp. turbogenerator at the city waterworks. J. R. Fell is the city engineer in charge of the project.

Weehawken, N. J.—The New Jersey Board of Commerce and Navigation, Trenton, has granted permission to the Cunard Terminal Corp., a subsidiary of the Cunard Steamship Co., 24 State street, New York City, to construct its freight terminal at Weehawken, utilizing 1100 ft. of land along the Hudson river, in addition to 3900 ft. previously granted. The project will include the construction of eight two-story fireproof piers, and the same number of warehouse buildings, each 525 ft. wide; considerable electrical and mechanical equipment will be installed, including the erection of a power plant for operation, with electrically operated traveling cranes and other handling machinery. The project will cost about $30,000,000.

Altoona, Pa.—The Penn Central Light & Power Co. has filed application with the State Public Service Commission for permission to issue stock for $2,692,500, the proceeds to be used in part for proposed extensions and improvements.

Apollo, Pa.—Considerable electrical equipment will be installed in an addition to the local plant of the Apollo Steel Co., to consist of three one-story buildings, 185 by 350 ft., 78 by 412 ft., and 44 by 75 ft. The project will cost about $1,000,000.

Ardmore, Pa.—The Counties Gas & Electric Co. has made application to the State Public Service Commission for permission to issue bonds for $486,000 for proposed extensions and betterments in plant and transmission line.

Kingston, Pa.—The Luzerne County Gas & Electric Co. has made applica-

tion to the State Public Service Commission for authority to issue bonds for $1,150,000 and stock for $3,000,000 for proposed expansion.

Philadelphia, Pa.—The Cleveland Worsted Mills will make extensions and improvements in the steam department of its power house at its works, Allegheny and Emerald streets.

Philadelphia, Pa.—Henry Disston & Sons, Inc., has filed plans for the erection of an electric substation at its saw and file manufacturing plant, Milnor and Disston streets.

Philadelphia, Pa.—The saving to be effected by the Keystone Telephone Co. through the installation of its automatic telephone system is estimated at about $200,000 per year. The entire installation will represent an investment of over $13,500,000.

Philadelphia, Pa.—The Philadelphia Rapid Transit Co. is arranging to submit figures to the State Public Service Commission showing a valuation of system totaling $200,000,000. The company, it is said, will ask a valuation of about $300,000 per mi. of installed trackage and equipment, and which, at the present time, approximates 600 mi.

Pittsburgh, Pa.—The Bell Telephone Co. has been granted permission by the local federal engineers to construct a new aerial line over the Allegheny river, between Natrona and Braeburn, about 23 mi.

Pittsburgh, Pa.—The West Penn Power Co. has arranged for a bond issue of $3,000,000, a portion of the proceeds to be used for necessary expansion.

Reading, Pa.—The Metropolitan Edison Co., South Fifth street, has had plans prepared for the erection of a one-story addition to its power plant. Application has been made to the State Public Service Commission for permission to issue bonds for $66,000.

Williamsport, Pa.—The Lycoming Edison Co. has applied to the State Public Service Commission for permission to issue notes for $123,000 for proposed extensions and betterments in plants and system.

York, Pa.—The York Railways Co. is planning for the erection of two automatic electric substations.

Annapolis, Md.—Plans are under way for a merger of the Washington, Baltimore & Annapolis Railway with the Annapolis Short Line, to operate as one company, under the first noted name.

Baltimore, Md.—The city council has called a special election, November 2, to vote on a bond issue of $26,000,000 for municipal extensions and improvements in utilities, including electric street-lighting system.

Baltimore, Md.—The Pennsylvania Water Power Co. will build a large addition to its plant on the Philadelphia road.

Cumberland, Md. — Considerable electrical and mechanical equipment will be installed at the new laundry plant of the Crystal Laundry Co., and estimated to cost $250,000.

Elkton, Md.—The American Telephone & Telegraph Co., has completed the installation of a local underground conduit system and will abandon its aerial system in the upper section of Cecil county.

Frostburg, Md.—The Brophy Coal Co., operating at Midlothian, near Frostburg, is arranging for the immediate installation of electric equipment, including dumping apparatus and mine motors.

Mount Airy, Md.—The municipal authorities have concluded negotiations with the Hagerstown & Frederick Railway Co., Hagerstown, for the installation of an electric light and power system. The company will build an extension to its 33,000-volt transmission line from Frederick to Mount Airy, and construct a local substation for voltage cut-down service for local distribution. The borough officials at New Market and Monrovia are negotiating with the company for the installation of a similar local service.

Pocomoke City, Md.—Considerable electrical and mechanical equipment will be installed in the proposed new coal storage and refrigerating plant to be erected by the Peninsula Storage Co.

Westport, Md.—The Consolidated Gas, Electric Light & Power Co., of Baltimore, has completed the construction of its local generating plant. The new plant has a capacity of 120,000 kw. and will be operated by steam power.

Shipman, Va.—The Red Apple Orchard Corp. will build a power house in connection with its local canning plant, plans for which are now being prepared. R. M. Sherman is the head of the company.

Bluefield, W. Va.—The Point Lick Coal Co. is planning for the installation of new electrical equipment at its properties to cost about $42,000.

Williamson, W. Va.—The Williamson Electric Co. has arranged for a bond issue of $160,000 for proposed extensions and improvements. The company furnishes local light and power service, and has a contract with the municipality extending until 1937.

Bamberg, S. C.—The city council has approved a bond issue of $15,000 for extensions and improvements in the municipal electric power plant.

Pickens, S. C.—The Pickens Cotton Mill is planning for the installation of electrical equipment at its plant, to include lighting and power system.

Townville, S. C.—Frank McLeese is organizing a company to install and operate a local light and power system. The new organization will purchase electric power from the Southern Utilities Co., Anderson, S. C., and will build a transmission line from Portman to Townville, with installation of a local distributing system.

Union, S. C.—The city council has approved a bond issue of $30,000 for extensions and improvements in the municipal electric station and system. R. P. Morgan is the mayor of Union.

NORTH CENTRAL STATES.

Akron, O.—A proposed bond issue of $1,000,000 for a municipal power house was defeated in the city council. H. H. Esselstyn, electrical engineer, Detroit, advised a survey of the Northern Ohio Traction Co. power plant before taking steps toward building a municipal plant.

Burton, O.—The Public Service Co., recently organized, has made a 20-year contract with the Ohio Pail Co., Middlefield, for electric power for the city. The company is now constructing a transmission line to convey the energy.

Cleveland, O.—Parish & Bingham, 10600 Madison avenue, will soon award a contract for a one-story, 30 by 50 ft., power plant. Ernest McGeorge, 1000 Euclid avenue, is the engineer on the project.

Dover, O.—Work will start at once on improvement in the city waterworks system, including the purchase of the electric light plant now supplying it with power. Bonds to the amount of $200,000 have been sold for the improvement.

East Cleveland, O.—The Cleveland Electric Illuminating Co. has awarded a contract for a one-story, 43 by 49 ft., addition to its substation at 16301 Euclid avenue, at an estimated cost of $50,000.

Georgetown, O.—The village plans the construction of an electric light and power plant.

Lima, O.—The city council is preparing plans to obtain the necessary legislation to permit the issuing of $180,000 in bonds for the installation of boulevard lights.

London, O.—The Chamber of Commerce has recommended the sale of the municipal electric light and power plant to the highest bidder.

Columbus, Ind.—The Caldwell & Drake Iron Works has installed electric cranes and other power equipment at its new plant.

Fort Wayne, Ind.—The Fort Wayne Development Corp. plans the extension of street-lighting facilities in the city.

Goshen, Ind.—The power plant and other buildings of the Hartwell Coal Mining Co. were destroyed by fire, July 11, with loss estimated at $45,000.

Indianapolis, Ind.—The Imperial Drop Forge Co. has awarded a contract for a new power house to cost $100,000.

Portland, Ind.—Construction work on the new $150,000 municipal power plant will be completed about Aug. 1.

Richmond, Ind.—It is proposed to install a 5000-kw. turbine engine at the municipal electric light plant, at an estimated cost of $240,000.

Battle Creek, Mich.—Plans are being made for extending the street-lighting system from the end of the ornamental light line on South Jefferson street to Goguac lake.

Durand, Mich.—Plans are being prepared for an addition to the city waterworks, including electrically driven equipment, the entire work to cost about $50,000. R. A. Murdock, Detroit Free Press building, Detroit, is the engineer on the project.

Escanaba, Mich.—The Escanaba Paper Co. will soon complete its power line extending from the company's dam on the Escanaba river to a new dam at Kingsley's Falls. When the line is completed power will be sold to villages and private individuals along it.

Lansing, Mich.—Modern electrical equipment will be installed in the new test department building of the Reo Motor Car Co., now in process of construction.

Decatur, Ill.—The common council has passed an ordinance providing for an ornamental lighting system on Cobb avenue.

East Chicago, Ill.—The board of public works will purchase a 75-hp. and a 125-hp. motor and other equipment to operate pumps at the waterworks.

Ottawa, Ill.—The city plans to make extensions costing $30,000 to the street-lighting system.

Beloit, Wis.—The Beloit Iron Works will erect a steel and brick storage building, 60 by 160 ft. Two 3-ton electrically operated traveling cranes will be installed.

Green Bay, Wis.—The Northern Peshtigo Power Co. and The Northern Peshtigo Pulp Co. have been incorporated separately, each with capital stock of $1,000,000 and will establish and operate respectively a hydroelectric generating plant and a pulp and paper mill on the Peshtigo river. V. J. Kelliher, A. T. Pamperin and T. S. Pamperin, all of Green Bay, are well known in the light, power and paper industry of Northern Wisconsin.

Port Washington, Wis.—The city commissioners are taking bids for equipment to be placed in an addition to the municipal electric light and water plant.

Vesper, Wis.—The Wood County Rural Electric Co. has been incorporated with capital stock of $100.000 to build, operate and maintain electric light, power and heating utilities in Wood and Portage counties. W. W. Clark. Fred Piltz, Anthony Zimmerman, Charles Korn and John K. Blonien are the incorporators.

Wausau, Wis.—The Wisconsin Electric Co. has started work on the first unit of a hydroelectric project on the Wisconsin river at Big Bull Falls. The work involves an immediate investment of about $450,000. L. A. DeGuere, Grand Rapids, Wis., is the consulting engineer on the project.

Grand Rapids, Minn.—The village will install a "white way" system of lighting on Main street.

Redwood Falls, Minn.—The Electric Telephone Co. will erect a telephone building.

Kansas City, Mo.—The Kansas City Light & Power Co. plans to install five new substations in the downtown district. The first station will be located at 10th and Grand avenues and the equipment will include a standard 1500-kw. rotary converter. All of the substations will be equipped with automatic generator sets for converting alternating to direct current.

Marshall, Mo.—A bond issue of $90,000 has been approved for the establishment of a municipal electric power plant, to be operated in conjunction with the waterworks system.

Mexico, Mo.—The Mexico Power Co. has purchased the municipal electric light plant at Wellsville, Mo., and is now furnishing power to that city from its Mexico plant.

Grand Forks, N. D.—The Terminal Mills and Elevator, owned by the Industrial Commission of North Dakota, will require 17 electric motors of various sizes in the operation of the plant. Charles L. Pillsbury, 805 Metropolitan Life building, Minneapolis, Minn., is the engineer in charge of the project.

SOUTH CENTRAL STATES.

Neon, Ky.—The Neon Light Co. is planning for extensions and improvements in its local electric power plant to cost about $25,000.

Shubuta, Miss.—The town council has approved a bond issue of $12,000 for the installation of an electric lighting plant. J. P. Spinks is the mayor of Shubuta.

Beaumont, Tex.—The Beaumont Iron Works Co. will make additions to its plant here, consisting of a pattern shop and foundry building. The foundry will be equipped with a 16-ton electric crane.

Dallas, Tex.—It is announced by J. F. Strickland, president of the Dallas Power and Light Co., that extensive improvements will be made by that organization. The new work will include extensions and betterments to the power plant, the construction of a new warehouse and garage, a new cooling system at the power plant and additions and improvements at the East Dallas substation.

WESTERN STATES.

Miles City, Mont.—The Eastern Montana Telephone Co. will construct a line between Miles City and Broadus, at an estimated cost of $30,000.

Polson, Mont.—The Rocky Mountain Power Co., Butte, Mont., has filed applications for permits to build five dams for power purposes in the Flathead river.

Brigham, Utah.—An issue of municipal lighting plant bonds to the amount of $120,000 has been taken under consideration by the city council.

Spokane, Wash.—The Chicago, Milwaukee & St. Paul Railroad has apportioned $1,147,314 for the maintenance of the electrified divisions of the railroad in Washington.

Enterprise, Ore.—Construction work is to be started soon on a hydroelectric plant for the Enterprise Electric Co. The first unit will develop 1500 hp.

Phoenix, Ariz.—An auxiliary electric generating plant of 5000-hp. capacity, to cost $500,000, will be built at the Roosevelt dam.

INCORPORATIONS.

New York, N. Y.—The Progressive Electric Co. Capital stock, $50,000. To manufacture electrical products. Incorporators: Samuel B. Howard, Raymond J. Gorman and A. Roy Myers.

New York, N. Y.—The Art Display Lighting Co. Capital stock, $20,000. To manufacture electric lighting fixtures and equipment. Incorporators: A. W. Jenkins, M. M. Mittlemark and G. Singer, 2683 Briggs avenue.

Oneonta, N. Y.—The Traver-Blair Co. Capital stock, $100,000. To manufacture motor and electrical machinery. Incorporators: W. J. Blair, B. A. and A. Traver, 318 West 25th street, New York City.

Framingham, Mass.—The Wheelock Gas Appliance Co. Capital stock, $100,000. To manufacture electric and gas fixtures and appliances. Incorporators: Nelson T. and Frank H. Wheelock, Framingham, and Josiah J. Markle, Wilmington, Del.

West Chester, Pa.—The Ivins-Lamborn Electric Co., Inc. Capital stock, $25,000. To manufacture electrical products. Walter S. Grosh is the treasurer of the company.

Lewisburg, Ky.—The Lewisburg Electric Lighting Co. Capital stock, $10,000. To operate a local light and power system. Incorporators: O. A. Bland, E. W. Duncan and James Westrey.

Indianapolis, Ind.—The Hercules Manufacturing Co. has been incorporated with capital stock of $400,000 to manufacture electrical machinery. The incorporators are Jackson Carter, E. M. McDaniel and W. L. Taylor.

Creston, Ia.—The Creston Mutual Telephone Co. has been incorporated with capital stock of $50,000. J. C. Sullivan is the president of the company.

Milwaukee, Wis.—The Milwaukee Boiler Manufacturing Co. has been incorporated with capital stock of $200,000. I. M. Bean, Otto A. Ehbe and W. D. Johnson are the incorporators.

Houghton, Mich.—The Calumet Motor Co. has been incorporated with capital stock of $100,000 for the manufacture of fractional horsepower motors. Ocha Potter, Houghton, is president, and John G. Bannetts, Calumet, secretary-treasurer of the new company.

Los Angeles, Cal.—The Cannon Electric Development Co. has been incorporated with capital stock of $20.000 to manufacture electrical appliances and equipment. John F. Torrey and Byron L. Marvel, 4034 Homer street, are the incorporators.

FOREIGN TRADE.

[Addresses of firms referred to in these trade opportunities may be obtained by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or its branch and local co-operative offices. Request for each opportunity should be on a separate sheet and the file number given.]

Electric Pumps (33,251)—An electrical engineer in Brazil desires to purchase and secure an agency for the sale of domestic electric pumps of from ½-inch to 1-inch suction, capable of elevating water from 3 to 20 meters, 220-volt electric motor, to be economical in consumption of electricity. Quotations should be given c. i. f. Brazilian port. Cash to be paid against documents.

Electrical Goods (33,254)—A commercial agent in Bulgaria desires to secure an agency for the sale of electric installations, lamps, electric wire. Quotations should be given c. i. f. port of Varna. Correspondence should be in French.

Electrical Tools, Etc. (33,288)—Agencies are desired by a merchant in France for the sale of portable electric tools, vacuum cleaners, washing machines, electrical appliances and machinery, barbers' supplies, drugs, and hospital supplies. Correspondence may be in English.

FINANCIAL NEWS

Comment on the Financial Outlook in the Electrical Industry, New Securities, Reports of Earnings, Dividends and Utility Stocks

Earnings of Cities Service Co. Show Increase.

Earnings of the Cities Service Co. for June and the six months ended June 30, 1920, show surplus earnings for the six months after fixed charges and available for dividends to be $11,425,581, against $9,461,532 for the corresponding period of last year. On this basis, the company is showing increases in surplus for dividends at the rate of approximately $3,900,000 annually in excess of the 1919 earnings.

For the twelve months ended June 30, 1920, there was earned on the average amount of common stock outstanding, $40.13 a share. As this period embraces six months of the 1919 year when earnings below the rate maintained this year, current earnings for 1920 are considerably in excess of the $40 a share figure.

Following a meeting of directors it was announced that the company had extended to holders of series "C" 7% convertible gold debentures of record July 1, the privilege of converting on Aug. 1, or the first day of any month thereafter; 10% of the amount of their debenture holdings. This is the sixth 10% partial conversion privilege extended to debenture holders. The issue is entirely convertible on Jan. 1, 1921.

The earnings statement follows:

	1920.	1919.
June gross	$2,137,240	$1,601,017
Net earnings	2,075,714	1,546,877
Surplus after fixed charges	1,922,441	1,379,504
Six months' gross	12,743,299	10,762 818
Net earnings	12,391,400	10,400,863
Surplus after fixed charges	11,425,581	9,461,532

Utica (N. Y.) Gas & Electric Co. Offers Bond Issue.

Harris, Forbes & Co., New York City, are offering a new issue of $1,700,000 Utica Gas & Electric Co. 7½% five-year general mortgage, convertible bonds, due March 1, 1925, at 96 and interest to yield 8%. The proceeds of the sale of bonds are to be used to reimburse the company for expenditures made in additions and extensions to its hydroelectric plants. The company does an electric light and power business in Utica, N. Y., and throughout the Mohawk Valley. During the year ended May 31, 1920, more than 80% of the electricity sold by the company was generated at its hydroelectric plants. The net earnings are more than twice the interest on all bonds outstanding, including present issue. Gross earnings from its electric light and power business have increased over 121% since 1914.

Chattanooga Railway & Light Co.

(Light and power department.)

	1920.	1919.
May gross	$ 108,660	$ 74,545
Net after taxes	36,988	15,193
Surplus after charges	14,005	*6,971
Twelve months' gross	1,186,365	987,000
Net after taxes	408,430	366,965
Surplus after charges	156,272	115,527

*Deficit.

Republic Railway & Light Co.

	1920.	1919.
May gross	$ 623,506	$ 491,773
Net after taxes	126,390	118,602
Total income	151,486	143,081
Surplus after charges	29,822	29,033
Twelve months gross	7,048,091	5,727,216
Net after taxes	1,734,495	1,355,612
Total income	1,910,992	1,584,765
Surplus after charges	502,025	262,655

General Gas & Electric Co.

	1920.	1919.
May gross	$ 885,285	$ 707,646
Net after taxes	152,470	213,673
Twelve months' gross	9,940,171	8,395,022
Net after taxes	2,662,426	2,349,093

Louisville Gas & Electric Co. to Sell $3,500,000 in Bonds.

Bonbright & Co., Inc., H. M. Byllesby & Co., and the Federal Securities Corp., all of Chicago, are offering $3,500,000 in Louisville Gas & Electric Co. bond secured 8% gold notes, due Jan. 15, 1923. Net earnings of the company, excluding depreciation for year ended May 31, 1920, after deducting all prior annual charges, are nearly three and one-half times the annual interest requirements on these notes. Net earnings for the same period are equal to over one and one-half times the annual charges of the total funded debt, including interest on the present issue. The Louisville Gas & Electric Co. and affiliated companies own and operate, without competition, the entire gas and electric properties of Louisville, Ky. Notes will be secured by a trust agreement in which the company will agree to pledge with the trustee, on or before Aug. 15, 1920, $5,250,000 general mortgage 6% bonds, due Jan. 15, 1923, as collateral.

Tennessee Power Co.

	1920.	1919.
May gross	$ 200,730	$ 149,720
Net after taxes	86,181	49,434
Surplus after interest charges	32,051	*4,949
Twelve months' gross	2,176,370	2,385,001
Net after taxes	879,111	930,437
Surplus after interest charges	234,333	291,643

*Deficit.

Columbia Gas & Electric Co.

(And Subsidiary Companies.)

	1920.	1919.
June gross	$1,033,720	$ 837,919
Net after taxes	492,689	411,085
Total income	714,837	579,572
Surplus after charges	296,978	178,148
Six months' gross	7,500,727	6,108,464
Net after taxes	3,955,195	3,132,201
Total income	5,271,358	4.133,636
Surplus after charges	2,775,639	1,865,497

Philadelphia Electric Co. Shows Good Earnings.

Earlier information to the effect that Philadelphia Electric Co. earnings are surprisingly good and on a basis sufficient to show, after the preferred stock has been issued, substantially increased earnings for the common, is confirmed by an official estimate indicating over 11% on the common after deducting a full year's dividend on the preferred. The estimate is based on five months actual results, including subsidiary companies, and as a matter of fact only a few months' dividend on the $6,000,000 8% cumulative preferred stock will have accrued so that the balance really earned for the $30,000,000 common this year should be nearer 12% than 11%. Though there is nearly $400,000 more common stock outstanding than at the close of last year and $5,000,000 more than two years ago, the return shown for the common will be greater than ever before.

United Light & Railways Co. and Subsidiaries.

(For twelve months ended May 31, 1920.)

	1920.	1919.
Twelve months' gross	$10,848,976	$9,759,721
Net after taxes	3,102.885	2,896,370
Surplus after charges	1,281,822	1,144,388
Balance after preferred dividends	678.228	537,359

Dividends.

The Fort Worth Power & Light Co. has declared its regular quarterly dividend of 1¾% on its preferred stock, payable Aug. 2 to stockholders of record July 21.

The Idaho Power Co. has declared its regular quarterly dividend of 1¾% on its preferred stock, payable Aug. 2 to stockholders of record July 20.

The Electric Utilities Corp. has declared its quarterly dividend of 1¼% on its preferred stock, payable July 15 to stockholders of record July 6.

WEEKLY COMPARISON OF CLOSING-BID PRICES OF SECURITIES OF LEADING ELECTRICAL COMPANIES.

Quotations furnished by F. M. Zeller Co., Rookery Bldg., Chicago.

	Div. rate. Per cent.	Bid July 20.	Bid July 27.
Public Utilities—			
Adirondack Electric Power of Glens Falls, common	6	10	10
Adirondack Electric Power of Glens Falls, preferred	6	70	70
American Gas & Electric of New York, common	10+extra	101	100
American Gas & Electric of New York, preferred	6	35	36
American Light & Traction of New York, common	..	124	121
American Light & Traction of New York, preferred	6	80	81
American Power & Light of New York, common	4	46	47
American Power & Light of New York, preferred	6	65	65
American Public Utilities of Grand Rapids, common	..	4	4
American Public Utilities of Grand Rapids, preferred	7	16	16
American Telephone & Telegraph of New York	..	92	91
American Water Works & Elec. of New York, common	..	2	2
American Water Works & Elec. of New York, particip	7	6	6
American Water Works & Elec. of New York, first preferred	..	37	36
Appalachian Power, common	..	6	6
Appalachian Power, preferred	7	18	18
Cities Service of New York, common	+extra	326	316
Cities Service of New York, preferred	6	66	66
Commonwealth Edison of Chicago	8	102	102
Comm. Power, Railway & Light of Jackson, common	..	17	18
Comm. Power, Railway & Light of Jackson, preferred	6	38	38
Federal Light & Traction of New York, common	..	7	7
Federal Light & Traction of New York, preferred	..	43	43
Northern States Power of Chicago, common	..	28	28
Northern States Power of Chicago, preferred	ex.div.7	76	76
Pacific Gas & Electric of San Francisco, common	..	46	46
Public Service of Northern Illinois, Chicago, common	7	71	67
Public Service of Northern Illinois, Chicago, preferred	6	75	74
Standard Gas & Electric of Chicago, common	..	13	13
Standard Gas & Electric of Chicago, preferred	6	35	35
Tennessee Railway, Light & Power of Chattanooga, common	..	½	½
Tennessee Railway, Light & Power of Chattanooga, preferred	6	2	2
United Light & Railways of Grand Rapids, common	4	18	19
United Light & Railways of Grand Rapids, preferred	6	57	58
Western Power of San Francisco, common	..	15	15
Western Union Telegraph of New York	extra	83	82
Industrials—			
Electric Storage Battery of Philadelphia, common	4	98	100
General Electric of Schenectady	8	142	146
Westinghouse Electric & Mfg. of Pittsburgh, common	7	53	52